

# The Australian and New Zealand Journal of Surgery

APRIL, 1943.

## TABLE OF CONTENTS.

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### ORIGINAL ARTICLES—

|   | PAGE                |
|---|---------------------|
| OCULAR INJURIES OF SOLDIERS IN THE MIDDLE EAST . . . . .                              | W. J. L. Duncan 235 |
| HYDATID CYSTS: THEIR LOCATION IN THE VARIOUS ORGANS AND TISSUES OF THE BODY . . . . . | L. Barnett 240      |
| SOME EXPERIENCES IN THE TREATMENT OF FOREIGN BODIES IN THE CHEST . . . . .            | E. S. J. King 249   |
| ACTINOMYCOSIS OF THE URINARY SYSTEM (PART II) . . . . .                               | S. S. Gardiner      |
| WITH A SUPPLEMENTARY ARTICLE ON AN ASSOCIATED INFECTION OF THE LIVER . . . . .        | D. A. Welsh 261     |

### CASE REPORTS—

|   |                   |
|---|-------------------|
| ARTERIO-VENOUS (CAROTID-JUGULAR) FISTULA AND CAROTID ANEURYSM . . . . . | E. S. J. King 285 |
|---|-------------------|

### SURGERY IN OTHER COUNTRIES—

|  |     |
|--|-----|
| PRIMARY CHOLANGIOGRAPHY . . . . .  | 289 |
| COMBINED "EVIPAN" AND NITROUS OXIDE AND OXYGEN ANÆSTHESIA . . . . .  | 290 |
| A SIMPLIFIED METHOD FOR OBTAINING ROOT ANÆSTHESIA OF THE SECOND AND THIRD BRANCHES OF THE FIFTH NERVE BY THE EXTRAORAL ROUTE . . . . . | 291 |
| THE APPROACH TO THE SCIATIC NERVE IN ITS UPPER THIRD . . . . .   | 292 |
| SOME POINTS IN THE OPERATIVE MANAGEMENT OF NON-UNITED FRACTURES . . . . .  | 292 |
| A NEW OBSERVATION ON THE RADIOGRAPHIC DIAGNOSIS OF THE DAMAGED KNEE CARILAGES . . . . .  | 293 |

### REVIEWS—

|   |     |
|---|-----|
| MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS . . . . . | 294 |
| BLOOD SUBSTITUTES AND BLOOD TRANSFUSION . . . . .                           | 294 |
| A SHORT HISTORY OF CARDIOLOGY . . . . .                                     | 295 |
| WAR INJURIES OF THE CHEST . . . . .   | 295 |
| SURGERY OF MODERN WARFARE . . . . .   | 296 |
| PRACTICAL MALARIA CONTROL . . . . .   | 296 |

## Royal College of Surgeons of England.

### JACKSONIAN PRIZE.

THE Council of the Royal Australasian College of Surgeons has been advised by the Council of the Royal College of Surgeons of England that the subject chosen for the Jacksonian Prize for the year 1944 is as follows: "The Causation and Treatment of Delayed Union of Fractures of the Long Bones." Full details governing the conditions of the prize will be announced at a later date.

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References to articles and books should be carefully checked. In a reference the following information should be given without any abbreviation: initials of author, surname of author, full title of article, name of journal, volume, full date (month, day and year), number of the first page of the article. If a reference is made to an abstract of a paper, the name of the original journal, together with that of the journal in which the abstract has appeared, should be given, with full date in each instance.

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# THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY

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No. 4.

## OCULAR INJURIES OF SOLDIERS IN THE MIDDLE EAST.<sup>1</sup>

By W. J. L. DUNCAN,  
*Major, Australian Army Medical Corps.*

OCULAR wounds experienced on active service present many features not seen in the ordinary eye injuries of civilian life. It may be of interest therefore to give a brief review of the ocular injuries of soldiers admitted to an Australian general hospital during the Libyan campaigns of 1941.

As a rule these patients did not arrive at the Australian general hospital to which I was attached until seven to fourteen days after being wounded. Thence onwards they were under my care until a medical board decided whether they were to remain in the Middle East or return to Australia. In many instances an eye had been so badly disorganized that it was necessary to excise it at once, or in a few instances panophthalmitis had developed and the eye was removed at a hospital *en route*.

In all, fifty-five soldiers who had sustained a perforating injury of one or both eyes were admitted. Of these thirty-three came from Tobruk. Thirty-three belonged to the infantry, thirteen to the engineers, three to field ambulances, two to anti-tank regiments, two to the Army Service Corps, one to the Royal Tank Corps, and one to the Royal Australian Air Force.

### ACTION OR ACCIDENT.

Not all penetrating ocular wounds were sustained directly in action; of the fifty-five patients forty were wounded in action, the majority when out with fighting patrols; fifteen were injured as a result of causes which might be classed as accidental.

For example, one day in August, 1941, Private B., a member of a field ambulance, was engaged in cleaning up the lines on the beach at Tobruk (his job was hygiene and sanitation). He had picked up a few tins, rubbish and papers, when suddenly one of the tins exploded in his hands. He sustained a traumatic amputation of his right hand, cordite burns of chest and abdomen and wounds of face and eyelids; the right eye was so badly disorganized that only remnants could be found to enucleate at an Australian general hospital on the same day.

The engineers fared badly in this respect.

One sapper, while boring with a jackhammer, preparatory to placing bombs under the road, struck an unexploded detonator charge. Both his eyes were perforated by foreign bodies and the left eye had to be enucleated.

Another was engaged in laying a mine in a tank trap in the front line at Tobruk when an old Italian land mine exploded, causing multiple superficial wounds of his legs, arms, chest and face, perforating injuries of both eyes and loss of his right eye.

<sup>1</sup> Accepted for publication on December 11, 1942.

One other was laying a reclaimed Italian booby trap mine, and, as he covered it with earth, it exploded, causing multiple injuries including perforation of both eyes and the eventual loss of his right eye.

A sapper while laying booby traps at Tobruk—he was holding several in one hand and a pick in the other—tripped over a wire and the booby traps fell and exploded.

An accidental explosion while he was loading hand grenades caused another sapper multiple perforating injuries of both his eyes and total blindness.

An infantry soldier while walking along near the front line at Tobruk accidentally kicked a hand grenade lying buried in the sand. One ran over a mine with a wheelbarrow; two others were laying mines in tank traps, and one was driving a truck when a wheel went over a mine.

A few of these accidental injuries were akin to those met with in civil life.

A small metallic foreign body that was successfully removed with the aid of the giant magnet by Major Cockburn at a base hospital in Cairo, entered the soldier's eye while he was hammering a steel pin in a motor truck.

A soldier while picking stone felt something hit him in his left eye. There was a perforating injury of the eye by a foreign body that was not radio-opaque and probably a splinter of stone.

While another soldier was changing a truck tire, the tire blew out and the rim of the wheel struck him in the face, causing injury to his forehead and rupturing his right eye.

#### TYPE OF PROJECTILE CAUSING THE OCULAR INJURIES.

Not every soldier who received an ocular wound knew with certainty the offending projectile; from those who did know I was able to gather the following information. Nine were wounded by hand grenades, eight by mortar bombs, seven by shrapnel, six by land mines, five by booby traps, two by bullets and one by a detonator explosion.

It is noteworthy that only two soldiers lost an eye through bullet wounds.

The first, while his platoon was attacking an Italian post, was hit in his right eye. Portion of the right upper eyelid was shot away and the eye completely disorganized. The eye was eviscerated on the same day at an Australian general hospital, where it was found that the brass casing of the bullet had penetrated the orbital tissue on the medial aspect of the globe; it was removed from the apex of the orbit.

The second soldier, a member of the Queen's Own Cameron Highlanders, sustained his wound while attacking the Germans. The bullet pierced the right lower lid nasally, perforated and badly damaged the right eye, and made its exit in front of the right ear. The right eye was eviscerated and an X-ray examination revealed a fracture of the floor of the right orbit.

Hand grenades consisted mainly of aluminium, lead, tin, little pellets of lead and small pieces of jagged metal. Mortar bombs contained iron, aluminium and all sorts of metal rubbish. Generally the projectiles appeared to consist of metallic alloys of low ferrous content.

#### THE INTRAOCULAR METALLIC FOREIGN BODY.

Of the fragments which caused the ocular injuries most were large and irregular in shape and generally they damaged the eye so extensively that the eye had to be removed; some traversed the eye and lodged in the posterior part of the orbit. When small foreign bodies pierced the eye, they were frequently multiple.

These metallic intraocular foreign bodies, although demonstrable with X rays, were usually found to have poor magnetic qualities, consisting as they usually did of non-magnetic alloys of aluminium, tin, lead *et cetera* with low iron content. A few, however, when removed from the eye did show a weak attraction to the magnet.



## INDIRECT PROJECTILES.

In a number of cases in which there was unmistakable clinical evidence of perforation of the globe by a foreign body, no foreign body was demonstrable by X rays. These foreign bodies without doubt consisted of tiny particles of stone, sand *et cetera* blown up by the explosion of the shell or bomb. As Dr. Shimkin states, "indirect projectiles accompany every explosion and thanks to their having acquired great speed cause injury to the globe of the eye no less dangerous than that of the shell fragments. Artillery activity inflicts wounds not only through fragments of bombs, shells and shrapnel but also by innumerable fragments of stone, cement and sand which on account of their enormous kinetic energy tear through the cornea and sclera."

In a personal communication to me from Tobruk, Major Claude Morlet wrote:

Several eyes with penetrating wounds showing no foreign bodies have within forty-eight hours developed a gross panophthalmitis and after enucleation have been found to contain gravel or small stones. Aluminium fragments are the usual content of enucleated globes as grenades and booby traps or bombs do most of the damage here, rather than bullets or high explosives.

In the case of these indirect projectiles and small fragments of non-magnetic alloys of aluminium *et cetera*, the chief danger appeared to be from infection carried into the eye. If panophthalmitis did not develop, the foreign bodies appeared to be well tolerated. In my series of cases there were six patients in whom there were obvious signs of perforation of one or both eyes by a foreign body, but no radio-opaque foreign body could be demonstrated. These eyes became perfectly quiet with treatment and were retained.

One of these soldier patients sustained his injury while picking stone, one was blown up by a booby trap and another by a land mine. A fourth, while walking in the dark, accidentally kicked what he thinks was a hand grenade. In the case of another a hand grenade thrown exploded in the sand in front of him, and in the case of the sixth he dropped a booby trap he was carrying and it exploded at his feet.

In five other cases of perforating injury in which the eye was retained, radiography revealed that the metallic foreign body had traversed the eye and lodged in the orbit.

## THE FREQUENCY OF MULTIPLE FOREIGN BODIES.

As opposed to the single small flake of metal usually found in civilian perforating injuries of the eye, it was frequently found that numerous small foreign bodies had perforated an eye. In thirteen cases of this series of fifty-five ocular injuries both eyes had sustained perforating wounds. In no instance did sympathetic ophthalmia occur.

## ACCOMPANYING WOUNDS OF FACE AND OTHER PARTS OF THE BODY.

Compared with civilians suffering from eye injuries, a very great number of patients sustained accompanying wounds of the face, head and other parts of the body. Of the fifty-five admitted to our hospital, twenty-five had wounds, mostly superficial, of the face, with or without injuries to the other parts of their bodies, and another ten had bodily injuries without any facial injuries apart from that to the eye.

## OTHER COMPLICATIONS.

As would be expected, dust or debris, tiny pieces of stone or metal were frequently imbedded by the force of the explosion in the eyelids, the

cornea or the conjunctiva. This occurred often as a complication of a penetrating ocular wound, sometimes alone. On two or three occasions a flake of metal spent its force on the outer aspect of the sclera, causing a hæmorrhage into the retina beneath but not perforating the eye. Burns of the conjunctiva and cornea were occasionally seen and the eyelids were frequently lacerated. Damage to the vascular system of the chorioid and retina, as evidenced by hæmorrhage into these membranes and into the vitreous, was sometimes seen as the effect of direct concussion by metal or stone, but (it may be because I did not have the opportunity of examining the patients early enough) I saw no patient with ocular injury which I was convinced was due to blast concussion.

#### REMOVAL OF FOREIGN BODIES.

Few intraocular foreign bodies were successfully removed either with the aid of the giant magnet or without it.

In only three cases was a metallic foreign body successfully removed from the eye with the aid of the magnet, in two instances from the vitreous or posterior chamber and in one instance from the anterior chamber. Twice small non-magnetic foreign bodies in the anterior chamber of the eye were removed with forceps.

#### NUMBER OF EXCISIONS.

As has been previously remarked, these wartime perforating ocular injuries were marked by the high percentage in which the eye was so badly injured that there could be no doubt as to the choice of treatment—that is, evisceration or enucleation. Of the fifty-five patients who had sustained a perforating injury of one or both eyes, in thirty-one the eye was so badly disorganized that it had been excised within forty-eight hours. On account of infection a few others had to be excised in the next few days. Eight others were retained for periods ranging from one to six weeks and then had to be removed. In all, twenty-one soldiers lost their right eyes, twenty the left eye, and two unfortunate but very brave men had to have both eyes removed.

#### TOTALLY BLINDED MEN.

Apart from the two just mentioned, two other soldiers were rendered permanently blind as the result of multiple tiny perforating injuries of both eyes, making a total of four.

#### ONE-EYED SOLDIERS.

At first all soldiers who lost an eye were sent back to Australia. In October, 1941, the following ruling as to the classification of one-eyed soldiers was given by the Director of Medical Services, Australian Imperial Force (Middle East):

Soldiers who have lost the sight of one eye through accident in the Middle East or from battle casualty will be classified "C2" or "D".

If the soldier's good eye has eyesight of  $\frac{3}{4}$  and he desires to remain in the Middle East, a note to this effect should be made by the Medical Board in A.A.F.D.2, Part III, para. 9.

In order that relatives in Australia could receive early official notification, Australian Imperial Force Headquarters were informed without delay of all soldiers who had lost an eye.

#### TREATMENT.

Regarding treatment for the soldier with an intraocular foreign body there are three requirements: (a) a speedy and a smooth journey to the care

of an ophthalmic surgeon, (b) accurate localization of the foreign body, and (c) a powerful magnet. The first is not easy of attainment in the army. In many cases ten days or more elapsed between the time of wounding and admittance to hospital. Delay not only mars the prospect of success, but is a source of potential danger to the other eye. Means of accurate localization are essential, and, when the foreign body is non-magnetic, an indispensable preliminary to an attempt at removal. A powerful magnet must be available. It is useless to send a boy on a man's errand, and it is a delusion to think that one can snare the weakly magnetic foreign bodies of modern warfare with a magnet of feeble strength.

#### SUMMARY.

One may summarize the main features of these ocular perforating injuries of war in the following way:

1. In a large percentage the eye was so badly damaged as to demand immediate excision.
2. Frequently penetration occurred without marked external signs.
3. Indirect projectiles of stone and sand frequently complicated the picture.
4. Often the intraocular foreign body was not demonstrable by X rays, and the majority were only feebly magnetic, or non-magnetic.
5. In about one case in four both eyes were penetrated and frequently the foreign bodies were multiple.
6. In three-quarters of the cases there were accompanying wounds of the face and/or other parts of the body.
7. Sympathetic ophthalmia did not occur.
8. Early admission to a hospital with adequate equipment is a *sine qua non* of successful treatment in these distressing war injuries.

#### ACKNOWLEDGEMENT.

I wish to express my indebtedness to Major-General S. R. Burston, Director-General of Medical Services, for permission to publish this paper.

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## HYDATID CYSTS: THEIR LOCATION IN THE VARIOUS ORGANS AND TISSUES OF THE BODY.<sup>1</sup>

By SIR LOUIS BARNETT,

*Registrar-in-Chief of the Hydatid Registry; Chairman of Hydatid Research Committee, Medical School, Dunedin.*

A STUDY of the 1,617 records now filed in the Gordon Craig Library of the Royal Australasian College of Surgeons shows that in certain respects the generally accepted statistics regarding hydatid locations call for revision, at any rate as far as Australia and New Zealand are concerned.

Many authors of standard works, especially those dating back twenty years or so, have vitiated their location statistics by not differentiating primary and secondary cysts, and others have not realized that fully a third of the total of hydatid patients harbour cysts in more than one part of the body. Worth mentioning too is the fact that many lung cases are not recorded because the patients cure themselves by coughing up their cysts and never enter a hospital, and yet another fallacy arises from the tendency among clinicians to record only those cases which are of exceptional interest and not to bother about those of commonplace occurrence.

The doyen in the domain of hydatid research is, or was, Professor Félix Dévé, of Rouen. I write "or was" because I have had no word from this old friend for two years or more, and for aught I know his laboratory and possibly he himself may have been bombed into inactivity or even out of existence. In the year 1913 (nearly thirty years ago) Dévé<sup>(1)</sup> published the locations of 2,727 primary cysts (secondaries being carefully excluded) reported by the following observers: Cranwell and Vegas (Argentina), Pericic (Dalmatia), Ribera and Sans, Becker (Mecklenburg), Duprat (Uruguay), Magnusson (Iceland) and Dévé himself (France). Dévé's conclusions rightly carry great weight and have been generally accepted by modern writers, foreign and British, including Professor H. R. Dew, of Sydney, who is deservedly recognized as an authority on the subject of hydatid disease. Dévé's figures, however, particularly for the liver, lungs and bones, do not square with those obtained from a collective investigation of our Australasian Registry records, as can be seen from the accompanying diagram (Figure I), which is based on a study of 1,732 primary hydatid cysts noted in 1,617 Australian and New Zealand patients.

The outstanding difference is seen in the high relative proportion of lung invasions in both Australia and New Zealand—namely, 23%—which is more than double the percentage recorded for other countries. Several writers have in the past expressed the opinion that lung cysts are probably more frequent than the published figures indicate. Dew in his book on hydatid disease (1928)<sup>(2)</sup> indicates clearly his personal impression, shared by some other Australian writers, notably H. B. Graham, that pulmonary invasion is much more common than is usually supposed and is more like 18% in adults and 25% in children. Nevertheless, Dew quotes the tables given by Dévé as being generally accepted, and as late as 1937, in the "British Encyclopædia of Medical Practice", he gives the proportion of lung cases as 12%. In the German textbook on hydatid disease (1928)<sup>(3)</sup> Hosemann gives the figure for lung cysts as 10% and Lehmann as only 8%.

<sup>1</sup> Accepted for publication on July 31, 1942.

A remarkable infrequency of lung hydatids in Iceland has been noted by the radiologist Gunnlaugur Claessen, of Reykjavik (1935).<sup>(4)</sup> He states that out of 682 cases of echinococcus disease published by Icelandic authors, only 1.5% showed localization in the lung, and even this small proportion included some examples of lung invasion from a subjacent hepatic cyst.

Another point—a negative one—that is also of interest is the fact that in the alveolar type of hydatid infection, endemic in certain parts of southern Europe, the primary cysts are always in the liver and never in the lungs.

Post-mortem records of hydatid disease are not very helpful from the point of view of location, because liver cysts, being far more deadly than those of the lungs, are encountered in a disproportionately large number of autopsies. For example, in the third thousand autopsies recorded by the eminent Australian pathologist Dr. J. B. Cleland, in the *Archives of the Adelaide Hospital* for the year 1937, hydatid cysts were found in 26 cases and of these no less than 22 were liver invasions.

From the diagram it will be seen that in man at any rate the anatomical arrangement of the blood vascular system is the main factor—some say the only factor—that accounts for the lodgment of the hexacanth embryo and the subsequent formation of cysts in this or that portion of the human body.

A possible influence exerted by gravity is suggested by the much greater prevalence of cysts in the lower and more dependent regions of liver and lungs as compared with the upper. Other possible factors in cyst location as noted especially in the lower animals will be briefly described presently. I refer to such things as biological affinities, direct burrowing by the embryo into its final location, passage by way of lymph vessels, bronchial tubes, bile ducts, influence of traumatism, and so on.

#### THE EVENTS LEADING TO THE LOCATION OF CYSTS.

The modern view of the course of events leading to location of cysts may be described under several headings.

##### 1. Hatching of the Hydatid Hexacanth Embryo.

The hydatid ovum, having been swallowed by an appropriate host, hatches out in the upper part of the intestine as the result of its sojourn in moist, warm and alkaline environment. The old assumption that the eggshell has to

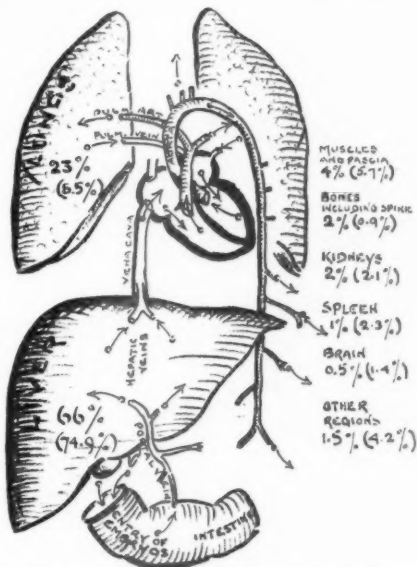


FIGURE 1. Showing the distribution by way of the blood vessels of hydatid embryos and the consequent locations of hydatid cysts in the various regions of the human body as seen in Australian and New Zealand patients. For comparison, Devé's statistics are shown in brackets.<sup>1</sup>

<sup>1</sup> This diagram is modified from one produced by Ivanissevich and Ferrari (1938) of Professor Arce's clinic at Buenos Aires, and to these authors grateful acknowledgement is expressed.

be dissolved by the acid gastric juice and the embryo liberated in the stomach has not been verified by experiment. At our Dunedin Medical School laboratory, warm-stage microscope and other lines of research have led us to agree with other observers that the echinococcus ovum is not particular as to an acid or an alkaline environment, and that the shell is not dissolved but cracks open after a few hours of incubation under favourable conditions, as a result of the urge or effort of the growing embryo to free itself from its imprisonment, much in the same way as a baby chick escapes from a hen's egg after its appropriate incubation (Dévé, 1907;<sup>(5)</sup> Penfold and Phillips, 1937;<sup>(6)</sup> Clunies Ross<sup>(7)</sup>).

Thus the hexacanth embryo is born. Its structure and that of its enveloping eggshell are diagrammatically shown in Figure II. Note that in size it is not much bigger than one of the largest type leucocytes—say, 25 microns in diameter—and that by virtue of its amœboid plasticity it is capable of squeezing through capillary channels. Measurements of the embryo have been published by many investigators of hydatid disease, but they do not all inspire confidence, chiefly because pains have not been taken to exclude dead,

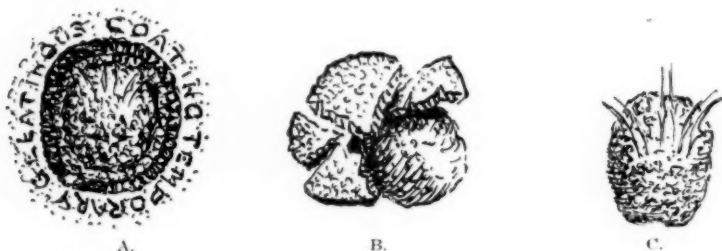


FIGURE II.—A. Hydatid egg (embryophore): actual size 38 by 35 microns. B. Eggshell breaks, liberating embryo. C. Hexacanth embryo: actual size 28 by 25 microns.

sometimes shrunken, sometimes swollen specimens, nor even to differentiate the actual embryo from the whole egg or embryophore, which naturally is considerably larger. Leuckart, Lehmann and Dévé give 25 microns as the average diameter of the embryo, and Clunies Ross in his particularly careful paper gives the size of the embryophore as 38 by 35 microns on the average. Miss E. J. Batham, M.Sc., Research Officer of the Dunedin Hydatid Laboratory, has recently carried out at my request a new series of scrupulously careful measurements, and finds that the average size of the hexacanth embryo is 28 by 25 microns and that living specimens show active movements of elongation and contraction, so that their diameters vary from a little above to a little below the figures given. It is of course conceivable, and the idea is alluring, that the size of the embryos and the size of the capillaries they enter vary in different animals and even in different countries, but any proof of such variation is at present lacking.

## 2. Penetration of the Mucous Membrane of the Upper Part of the Intestine (or Possibly Stomach).

No doubt many hydatid ova, when swallowed by man or beast, fail to hatch, or if they have hatched, they fail to secure accommodation, or if they have secured accommodation, fail to survive the defensive reactions of the new host. Mother Nature, as is usual with her seed distribution, allows lavishly for wastage of this kind. It is assumed that the more favoured and sturdy specimens of hexacanth embryo, when they come in contact with the intestinal wall, make use of their six little spiny processes, which are



there for business no doubt as grappling hooks and piercers, and aided also by amœboid movements, they work a passage through the epithelial layer into the deeper and highly vascular submucous tissue.

A point arises here which deserves careful study—study that it has not yet had in anything like convincing form. I refer to the question or problem of immunity, complete or partial, inherited or acquired, that on theory must exist in a large proportion of the animals and human beings that swallow the hydatid parasite, whether it be in the ovum or scolex stage (Turner, Dennis and Berberian, 1937;<sup>(8)</sup> Penfold, 1938;<sup>(9)</sup> N. Hamilton Fairley, 1938<sup>(10)</sup>).

### 3. Entry into the Portal Vein.

Quite soon the embryos delve through the endothelial wall and into the lumen of one of the ubiquitous blood capillaries of the portal vein system. There they find themselves borne towards the liver without the necessity of further exertion. Like tired rowers, they drop their oars and drift with the favouring stream. Thus after a few hours (Dévé,<sup>(11)</sup> Dew<sup>(12)</sup>) from the time of being swallowed they reach the liver capillaries.

The right portal vein is much larger than the left, so naturally it is the right lobe of the liver to which most of the embryos are conveyed. Actually the right lobe is invaded four or five times as frequently as the left. I consulted my colleague, Professor W. P. Gowland, of the Department of Anatomy of the University of Otago, on this point and he kindly gave me the following information:

*Regarding the Portal Vein.*—The right branch is usually about twice the diameter of the left branch and follows a course much more in direct line with the main trunk. It is, however, possible in addition that the current of blood from the intestine may remain separate from that from the spleen, and a larger proportion of it may enter the right branch. This kind of thing occurs with the discolouring siltage of rivers, and some confirmation has been obtained by observing the circulation through the living heart of the lamb at birth.

I should point out that in the case of tropical abscess and cancerous growths the prevalence on the right side is not with reference to the anatomical right and left lobes (separated by the falciform ligament), but to the portion of the liver to the right and left of the gall-bladder and the inferior *vena cava*. I have always followed Cantlie in dividing the liver in this way into two much more equal lobes, each supplied by the right and left branches of the hepatic artery, bile duct and portal vein. I taught this to McIndoe when he was a student and he confirmed it by research work when at the Mayo Clinic.

### 4. Lodgment in the Liver Capillaries: The First Filter.

The portal vein capillaries in the liver are a tight fit for the enclosed and prickly embryos, and about 70% of their number stick there and make a claim for board and lodging. If their claim is not resisted and if they like their quarters, they proceed to evolve themselves into hydatid cysts.

### 5. Lodgment in the Lung Capillaries: The Second Filter.

Approximately 30% of the embryos carried in the stream of the portal circulation manage to squeeze or wriggle through the liver capillaries, and are then carried, by way of the hepatic veins, into the inferior *vena cava*, thence to the right auricle of the heart, to the right ventricle and so by the pulmonary artery to the lungs and the next network of capillaries. Half of these—say, 15% of the whole—are filtered out and if conditions are favourable settle down and grow into pulmonary hydatid cysts. The right lung is twice as frequently invaded as the left, and on this point Professor Gowland writes:

*Regarding the Pulmonary Artery.*—Here I can offer little beyond the fact that the right branch, like the right lung, is slightly larger than the left. It has been stated, however (Selavounos. *Bibl. Anat.*, 21) that at the bifurcation of the main trunk a



spur projects into the lumen from the dorsal wall. This might have the effect of directing material to the right. At all events, a similar spur at the bifurcation of the trachea (formed by the last tracheal cartilage) is credited with diverting foreign bodies into the right bronchus.

It is of course conceivable that in the upper part of the alimentary canal a small number of the swallowed embryos may burrow into those little veins that go direct to the right side of the heart and thence to the lungs in this way, bypassing the liver. (Veins of Retzius *et cetera*.)

#### 6. Lodgment in the Systemic (Aortic) Capillaries: The Third Filter.

The remaining embryos, also roughly 15% of the whole, make their passage through both the liver and lung capillaries and are then carried, by way of the pulmonary veins, to the left auricle, to the left ventricle, to the aorta and so to the systemic capillaries in various parts of the body.

It seems highly probable that according to the area of the combined calibre of the arterial supply to various organs and tissue, the amount of blood supplied and the filtration efficiency of the capillary network (Hicks<sup>(12)</sup>), so varies the proportion of the embryos that are filtered out in the systemic capillaries of these different regions. For example, the muscles and fascia of the body as a whole receive the largest blood supply, the bones come next, then the spleen, the kidneys, the brain and so on, and to these tissues accordingly the corresponding distribution of the embryos is made.

**Bone Locations.**—Bone locations as recorded in Australia and New Zealand amount to approximately 2% of the whole, whereas in Dévé's list they form only 0.9%. Ivanissevich (1934),<sup>(13)</sup> of Buenos Aires, analysed 499 hydatid cases in Professor Arce's clinic and found bone location in 2%. As regards location in individual bones, selection seems definitely to depend on the total arterial calibre of their blood supply, the vertebral column coming first, then the pelvic bones, and then the femur, tibia, humerus, ribs, flat bones and small bones, more or less in that order.

#### INFLUENCE OF AGE ON HYDATID LOCATION.

It is now generally agreed that with very few exceptions hydatid infection occurs in childhood, although no pathological ill-effects may be noted before adult or even middle age is reached. My opinion is that young primary cysts in middle-aged patients are surgical curiosities, and, as Dew has well said, a hydatid cyst is usually just about as old as the patient. In certain parts of the body, however, notably the brain and the orbit, pressure effects are manifested by hydatid cysts much earlier than elsewhere. That is easily understood, but it does not mean that these parts of the body are specially selected for early hydatid invasion.

#### THE INFLUENCE OF SEX IN HYDATID LOCATION.

Most observers agree that in general hydatid infection is distributed fairly equally between males and females, but investigation of the registry and other records in my possession indicates that there is a distinct preponderance of the male as compared with the female sex. Out of 1,051 liver cases 587 are in males and 464 in females, and out of 369 lung cases 225 are in males and 144 in females. A possible, though not convincing, explanation of this male sex predilection is that though in their earlier years male and female children are equally exposed to infection, yet as they grow older country boys by their habits of life come more often in contact with the polluted dirt of the farmyard and homestead paddocks.

## MULTIPLICITY OF PRIMARY HYDATID CYSTS.

Multiplicity of primary hydatid cysts is not uncommon; indeed, it has been noted in fully a third of all cases, and Dew puts the figure at far higher than that (60%). As a rule, not more than two cysts are present, but as many as ten and even up to thirty or forty have been recorded; and wherever else multiple cysts may be located, the liver is sure to be the site of one or more of them.

Human beings are not likely to swallow hydatid ova in large numbers—for example, in whole proglotides—as no doubt sheep, cattle and pigs often do, but there are on record a few instances of human infection on this massive scale explicable in the same way. Secondary multiplicity referred to later is of course quite a different matter. Here one may find cysts by the hundred or even by the thousand.

It is interesting to note that when massive infestation has been observed in an individual, the filtering out of the embryos and the subsequent multiple cyst formation follow the same rule of anatomical localization. Dévé's figures<sup>(14)</sup> bearing on this point are quoted in support of this observation: liver, 82·8%; lung, 14·2%; spleen, 2·2%; kidney, 0·8%.

## OTHER AND RARER PATHS OF TRANSMISSION OF HEXACANTH EMBRYOS TO THE HUMAN BODY.

It is of course conceivable, though definite proof is lacking, that the embryo may on occasion use other channels than the blood vessels for reaching its final destination, and such theories as the following have received more or less support: (i) The embryo may burrow by its own efforts directly from the intestine into the liver or some other adjacent organ. (ii) It may burrow into and travel along a lacteal or lymph vessel. (iii) It may paddle its way up the bile ducts to the liver. (iv) It may enter the trachea and bronchi by inhalation with the dust of the atmosphere. This last theory was advanced many years ago by Dougan Bird, of Melbourne (1877),<sup>(15)</sup> to explain what he alleged was an exceptional frequency of lung cysts in arid and dusty localities in Australia. (v) It may be introduced beneath the skin through a wound, especially through such a wound as a bite from a dog harbouring hydatid ova or scolices about its jaws. A remarkable case of this kind is described by Toole, of Athens (1935):<sup>(16)</sup>

A country woman of Boeotia, aged thirty-five years, had been badly bitten on the left buttock by a dog four years previously. The wound took fifteen days to heal. Two years later she noticed a swelling, which was tender on pressure. It was incised by a doctor and grape-like cysts were evacuated. The wound remained healed for two years; then a painful swelling recurred with toxic symptoms, fever, rigors *et cetera*. The swelling was again incised, with similar result, but the discharge this time was purulent and persisted. Radical excision of the cyst complete with adventitia gave permanent cure.

The explanations given are as follows:

1. The history is one of mere coincidence, the bite of the dog having nothing to do with the location of the cyst.

2. The hexacanth embryo, which happened to be circulating in the patient's blood, settled at the site of trauma.

3. A scolex or scolices were implanted from the dog's mouth, the animal having perhaps just previously eaten infected offal.

4. Hydatid ova were implanted from the dog's muzzle, the ova having been transferred there from its anus. (Dévé has shown experimentally that subcutaneous cysts can result from the introduction of living ova.)

Toole himself favours the last-named explanation.

### LOCATION OF HYDATID CYSTS IN THE LOWER ANIMALS.

As is well known, the dog and its congeners the dingo, wolf, fox, jackal and hyena, do not come into this category. They harbour the parasite in the adult and not in the cystic stage. So in this country (New Zealand), at any rate, the dog is the sole distributor of hydatid cysts, although he never or almost never has them himself. There is, however, in addition to man a large array of animals that can and do act as hosts of the cystic stage of the hydatid parasite, including sheep, cattle and pigs in particular, and in lesser degree horses, camels, deer, goats, kangaroos, squirrels, monkeys, rats and mice, and many others. Rabbits, guinea-pigs and cats are all extremely difficult to infect by way of the mouth.

There are some peculiarities in the locations of hydatid cysts in the lower animals that are worth mentioning; for example, in cattle cysts of the lung are much more common than those of the liver; in horses cysts are rare except in the liver; in rabbits which are often infected with other cestode cysts, the hydatid variety does not occur at all in the animals in their wild state, and when successful feeding experiments are made on them in the laboratory, the cysts are limited to the kidneys. In squirrels experimentally infected the cysts are almost invariably in the lungs and nowhere else. The rate of growth, viability and fertility of the cysts vary remarkably in these animals; in cattle, for instance, they tend to early obsolescence and sterility, whereas in sheep, which are justly regarded as the optimal hosts, they become rich in scolices and are consequently very fertile.

### LOCATION OF SECONDARY CYSTS.

A fertile primary cyst, and in human beings a cyst which reaches the size of a hen's egg usually is fertile, contains living scolices and maybe living daughter cysts. These elements, if they escape from their parental shelter into a new situation, may there develop into secondary cysts.

An obliging host is essential for such development. It often happens that these gate-crashing invasions are resented and the defensive forces of the body are called on either to destroy the intruders or to abort their evolution. Hydatid pseudo-tuberculosis fibrotic granules (Dév  ) are sometimes seen as evidence of successful resistance.

#### *Secondary Cysts of the Abdomen, Including Pelvis.*

With very rare exceptions (less than 1%) all abdominal hydatids other than cysts of liver, spleen and kidneys are secondary. Most of them have resulted from a frank rupture or from an insidious leakage from a primary cyst of the liver, with consequent dissemination of scolices, or even of already formed daughter cysts, into the more dependent regions of the peritoneal cavity by gravity and abdominal movements.

In circumstances favourable to the parasite secondary cysts then form, sometimes only in ones or twos, sometimes in scores, or even in hundreds and thousands. A ruptured primary cyst of the spleen or other organs may in rare instances behave in like fashion (D  v  , 1901;<sup>(17)</sup> Barnett, 1941<sup>(18)</sup>).

#### *Secondary Cysts in the Pleural Cavity.*

When secondary cysts are present in the pleural cavity the primary cyst has usually bulged from the lung and then burst or leaked into the pleural cavity, thus sowing the seeds of future cysts.

In rarer cases a liver cyst has bulged upwards into the thorax and has similarly contaminated the pleural cavity. A striking example of this occurrence was illustrated in this journal by Barnett (1938).<sup>(19)</sup>

Secondary cysts may also arise in the lungs as the result of a rupture of a primary cyst into a bronchial tube with consequent dissemination of scolices. This process, called by Dévé (1931)<sup>(20)</sup> bronchogenic cyst formation, is a very rare occurrence.

*Secondary Cysts in Operation Areas, the Result of Errors in Technique  
(Implantation Cysts).*

When secondary cysts occur in operation areas, which is not often, they are usually located in the wound area in cases in which formalin has not been used at operation, and result from the spilling of live scolices or minute daughter cysts during the cutting and manipulating operations, or even during diagnostic paracentesis (Dévé, 1914;<sup>(21)</sup> Barnett, 1935<sup>(22)</sup>).

METASTATIC CYSTS.

As proved experimentally by Dévé and others, if a primary cyst ruptures or leaks into a heart cavity or into a blood vessel, daughter cysts or hydatid membrane or scolices may escape into the circulating blood stream and lead to hydatid emboli and hydatid toxæmia, and if these grave conditions are not promptly fatal, then to the subsequent development of secondary cysts in (a) lungs or (b) other parts of the body, notably the brain.

THE ALVEOLAR TYPE OF HYDATID CYST.

This malignant form of hydatid disease, limited as regards its geographical distribution almost, but not quite, without exception to the regions of Bavaria, Wurtemberg, Tyrol and South Russia, is strictly limited in regard to its location in the human body. In its primary stage it occurs only in the liver. Its secondary metastases may invade adjacent tissues and organs, and the lungs and even more distant parts of the body. (See articles in this journal previously published by Dew, 1931,<sup>(23)</sup> and by Meade and Barnett, 1941,<sup>(24)</sup> referring particularly to the work of Posselt and of Dévé.)

SUMMARY.

The location of hydatid cysts in this or that portion of the body is described, and the usual explanations are discussed as far as available knowledge permits. Special stress is laid upon the anatomical factors, but some attention is devoted to the little known influences of susceptibility, immunity, biological affinity, and peculiarities of terrain; for example, why lung cysts are seemingly much more common in Australia and New Zealand than they are in other hydatid countries.

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## SOME EXPERIENCES IN THE TREATMENT OF FOREIGN BODIES IN THE CHEST.<sup>1</sup>

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THE presence of foreign bodies in the tissues of the body is one of the most obvious problems of war surgery. That their removal is imperative in some circumstances and even in the saving of life and limb is beyond argument. When, however, the individual has avoided or overcome infection, and the foreign body is tolerated without untoward signs, the question of the desirability of removal becomes a nice one.

It is then necessary to determine whether the probabilities of late developments, such as infection, justify the hazards of removal. When the foreign body is readily accessible—for example, in a limb muscle or bone—it is usually promptly removed. The presence of a sinus or other complication, indicating the certainty of delayed convalescence, may determine an intervention even in unfavourable conditions.

When the foreign body, however, is quiescent and the removal is considered to be a more formidable procedure, one is inclined to adopt a more conservative attitude. In order to test the reasonableness of this attitude, a number of patients admitted to an Australian base hospital were closely investigated, and the following is an account of twelve consecutive cases in which the patients were operated on, and the conclusions drawn from them. They comprise the total cases in which the patients were operated on by the writer up to the present period. The only death amongst thoracic cases arriving at hospital during this period was one in which, in retrospect unfortunately, the patient was not operated on.

### CONDITIONS UNDER WHICH TREATMENT WAS CARRIED OUT.

When the earlier cases were considered it seemed desirable that the patients should be repatriated from the Middle East. The weather was hot and dry, thus making loss of fluid a certain complication to operation. There was also a considerable amount of dust. The possible advantages of the dry climate were counterbalanced by the occurrence, at all too frequent intervals, of epidemics of streptococcal infection of the throat. On the other hand, it was apparent that if these men could be returned to their units within a relatively short period (of, say, three to four months) the advantages of immediate operation were too great to be overlooked.

A decision to attempt operation was aided by the discovery in three cases of an abscess round the foreign body; and it may be stated at this stage that five frank abscesses were found in the first seven cases.

Certain difficulties were present. Segregation of the patients could not be carried out as completely as was desirable, not only because the number being admitted to hospital at some periods precluded the setting aside of small wards solely for them, but also because sufficient nursing personnel at these times was not available.

Facilities for operation in these cases were not at first of a very high order. Apparatus, for example, for pneumothorax and negative pressure, at first and indeed for most of the cases, was not available in the form obtain-

<sup>1</sup> Accepted for publication on September 25, 1942.



able in civil hospitals. They were, however, improvised and constructed in the hospital.

These points are mentioned merely to indicate that a successful outcome is not completely dependent on elaborate equipment nor necessarily on ideal conditions. The corollary is that the operative treatment of foreign bodies of the lung is not so serious a procedure as is sometimes thought.

#### TYPE OF PATIENT.

The patients were all young adults who had been, prior to receiving their wound or wounds, quite healthy and very fit. Their ages ranged from twenty-one to thirty-seven years.

At the time of operation their condition was good, though half of them still had some residual disability from the original hæmorrhage, pneumothorax *et cetera*, and in one case (Case XI) the patient was desperately ill from an anaerobic infection of the mediastinum.



FIGURE 1A. Antero-posterior view.



FIGURE 1B. Lateral view.

Figures 1A and 1B are skiagrams showing a small foreign body in the medial aspect of the left upper lobe (Case III).

The mental attitude was generally satisfactory, though four of the patients were of a definitely nervous temperament, and these, together with two others of apparently more phlegmatic type, required considerable care and attention during the early part of their stay in hospital, particularly during air raids.

#### THE FOREIGN BODIES.

The foreign bodies varied considerably in type, shape and size (Figure II). They may be grouped as follows:

| Type.                             | Number.                               |
|-----------------------------------|---------------------------------------|
| Shell casing .. .. .              | 6 (Cases I, II, III, VI, VIII and IX) |
| Bomb fragments .. .. .            | 3 (Cases V, X and XII)                |
| Bullet .. .. .                    | 1 (Case IV)                           |
| Machine gun bullet .. .. .        | 1 (Case XI)                           |
| Machine gun tracer bullet .. .. . | 1 (Case VI)                           |
| Total .. .. .                     | 12                                    |



In one case (Case II) a fragment of bone, corresponding in shape, size and position with the shadow observed on the skiagram, was removed and no other object was found. Subsequent X-ray examination showed that the metallic foreign body had not been removed.

The size of the foreign bodies (excluding bullets) was on an average half an inch in diameter. Two were smaller, three-eighth and one-quarter of an inch in diameter respectively. It is possibly of interest that these smaller foreign bodies had small but definite abscesses round them.

The positions of the foreign bodies were:

|                          | Number.                |
|--------------------------|------------------------|
| Lung—                    |                        |
| Right upper lobe .. .. . | 3 (Cases I, II and IV) |
| Right lower lobe .. .. . | 2 (Cases VII and VIII) |
| Left upper lobe .. .. .  | 2 (Cases III and VI)   |
| Left lower lobe .. .. .  | 1 (Case V)             |
| Pleura .. .. .           | 2 (Cases IX and X)     |
| Mediastinum—             |                        |
| Posterior .. .. .        | 1 (Case XI)            |
| Anterior .. .. .         | 1 (Case XII)           |
| Total .. .. .            | 12                     |

The foreign body in the posterior mediastinum was partly in the right lung and that in the anterior mediastinum partly in the right pleura. The course taken by the missiles is indicated in the diagrams (Figure III).

#### EARLY SIGNS AND SYMPTOMS.

It is not proposed to discuss the early signs and symptoms at length, since in all these cases information could be obtained only from the accounts of the patients (who in some cases were unable to remember clearly what had occurred) and from field medical cards. This information corresponded very closely, however, with observations previously made by the writer in the field.

Four principal groups of cases may be easily recognized:

1. Chest wall wounds, not "sucking" and with no immediate evidence of internal injury.
2. Chest wall wounds, not "sucking" but with hæmothorax or pneumothorax (or more usually a combination of these).
3. Chest wall wounds, "sucking".
4. Chest wounds complicated by non-thoracic injuries.

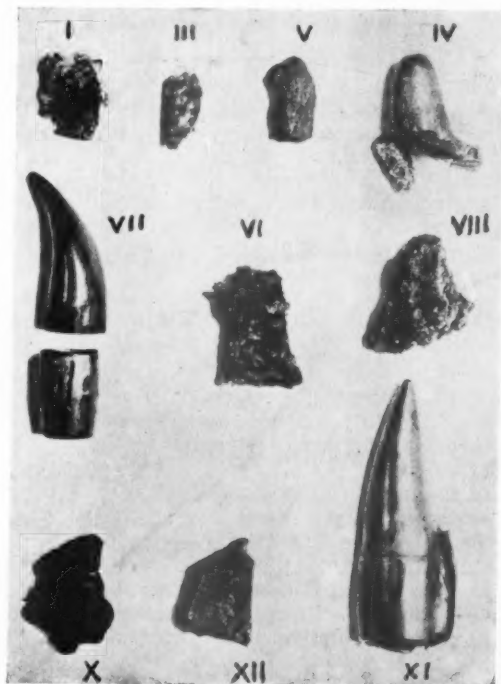


FIGURE II. Photograph of ten of the foreign bodies removed (natural size). Case numbers are indicated. Compare Figures IIIA, IIIB, IIIC and IIID.

1. Chest wounds, not sucking and with no immediate evidence of internal injury, present the least difficulty, and, apart from the occasional one with a brisk, even severe, external hæmorrhage may cause little trouble. Treatment required for shock is often minimal, and the problem as to whether there is a foreign body present or not, and whether it is in the chest wall or in the chest cavity, may be left until the patient has arrived at hospital. Investigation earlier may give some indication that special care is necessary during transport—for example, a soldier with a foreign body in the *pectoralis major* could be classed "walking wounded", whereas one with a foreign body even in the pleura or lung periphery could not. Operative interference, other

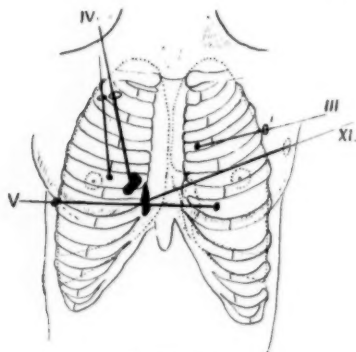


FIGURE IIIA.

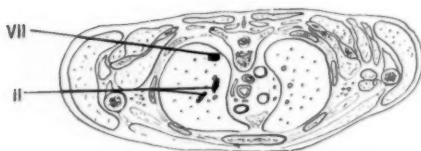


FIGURE IIIB.

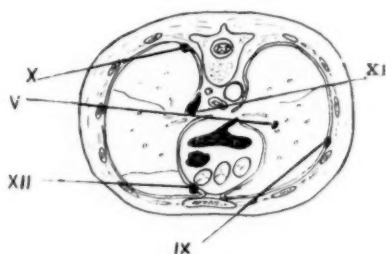


FIGURE IIIC.

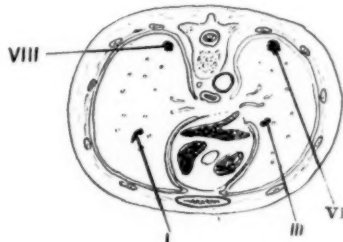


FIGURE IIID.

Figures IIIA, IIIB, IIIC and IIID show the course taken by the foreign bodies through the chest. The case numbers are indicated.

than routine toilet of the superficial wound, should not be carried out unless it is certain that the patient can be immobilized for at least two weeks after this.

2. Non-sucking wounds with intrathoracic complications may be subdivided into: (i) those with retained foreign bodies, (ii) those due to through-and-through wounds. In the early stage this subdivision is a matter of relatively little moment. The essential thing is to minimize the effects of the sudden alterations in vital capacity and intrathoracic pressures. The various changes—deviation of the mediastinal septum, mediastinal movements of the "flap" type, paradoxical diaphragmatic movements—require careful observation, accurate interpretation and early treatment. It is these that require attention, however, and not the foreign body present. Attempts to remove it will only enhance them without any adequately compensating advantage. Judicious aspiration of the affected pleura and sufficient sedation are the important features at this stage. As stated previously, no major operation that can conceivably be postponed should be undertaken until it is certain that post-operative treatment without transport from one place to another can be guaranteed for at least two weeks. Indeed, the patient may

not be in a fit state to be transported for some days even without the further insult of operation.

3. Little need be said about the "sucking" chest wound. Any open wound must be closed immediately, preferably by sutures, including the deeper structures. When the wound is airtight the case then falls into group 2.

4. In the fourth group are those cases in which wounds of other parts of the body may, to a greater or less extent, dominate the picture. It is necessary only that the thoracic condition be observed carefully from time to time to make certain that any alteration of the patient's condition is not due to a progressive intrathoracic lesion.

Cyanosis or dyspnoea, persistent tachycardia and, more important, displacement of the apex beat, dullness or hyperresonance of the chest and relative immobility of one side of the chest should all attract attention to a thoracic wound and to the possibility of its having caused grave intrathoracic damage.

In these cases, particularly in view of the associated lesion, any interference should be minimal.

#### RESULTS OF FOREIGN BODIES IN THE CHEST.

1. In some cases the injury to the intrathoracic tissues heals so completely that but little change can be found in the neighbourhood of the missile or along its presumed path. In these there is some thickening (fibrosis) in the immediate vicinity, and there are almost invariably some adhesions in its neighbourhood or along the path of its flight. Thus in one case in which no parietal adhesions were found (Case V) the mediastinal aspect of the lung was adherent to the mediastinum; the projectile had entered the right side of the chest, traversed the mediastinum and lodged in the left lung. Though some of the adhesions occur at the site of passage across the pleura, others at a distance are associated with an accompanying hæmorrhage.

2. In some cases there are considerable changes in the lungs along the line of passage of the missile and near this. It is clear in some that the damage inflicted is due not only to the foreign body itself but to pieces of bone (from splintered ribs) driven into the thoracic cavity. These fragments may be irregular in size and shape—in fact, splinters—but in Case II the piece of bone was practically identical in size and shape with the foreign body. The changes in the lung are hæmorrhage and a reactionary condition which might be termed a "traumatic pneumonitis". The degree of infection associated with this condition is difficult to assess, but from a consideration of the manner in which the condition resolves, the infection is probably (where present) of a low grade character. In some cases, however, it may persist for a long time—several weeks—and in such is probably associated with the retention of some radiologically translucent material.

3. In some cases an actual abscess is present. This was so in four of the ten cases of pulmonary foreign body in which operation was performed. It was not large in any case, but a definite collection of pus was found. On the application of culture methods to some of the foreign bodies removed, organisms were grown: *Staphylococcus aureus*, three; streptococcus, one; bacillus, Gram-negative, non-lactose fermenting, one; mixed growth of above organisms, one. In Case XI a pure culture of an anaerobe resembling, but different from, *Bacillus welchii* was found in a collection of bloody, but not purulent, material.

4. Pleural phenomena (in addition to the adhesions mentioned above) comprise areas of organized blood clot and empyema. The former are usually small laminated thickenings on the parietal wall, and the scanty degree of adhesion of the lung in such areas was unexpected.

Empyema is uncommon. It was not encountered in any of the cases operated on and in through-and-through wounds occurred only twice.

#### RADIOLOGICAL APPEARANCES.

The recognition of the missile presents no difficulties. It is usually of some characteristic form which indicates its nature, though deformed bullets may resemble shell or bomb fragments. Often only one is present, but it is not rare to find two pieces (Cases IV and VII). Minute particles were present in two cases in which the patients were not operated on.

The site of the missile may be determined by X-ray films taken in more than one plane (antero-posterior and lateral being the most useful), though more information may be obtained by screen examination. The surgeon should be present at such examination, since the amount of information to be obtained by this means is often most valuable when removal of the foreign body is to be undertaken. Movement of the foreign body on respiration, regular movements coincident with cardiac contraction, its relation (when in



FIGURE IVA. Antero-posterior view.



FIGURE IVB. Lateral view.

Figures IVA and IVB are skiagrams showing the foreign bodies in the right upper lobe (lower part). Case IV.

the posterior part of the chest) to one or other border of the scapula in its various positions and many other features are observations which may be of considerable assistance to the surgeon and can best be appreciated by him by his own observations.

Abscess in the neighbourhood of the projectile, areas of consolidation of the lung and collections of fluid or air in the pleura may be observed.

Further observations, when an artificial pneumothorax has been induced, will indicate the presence of adhesions, augmentation of pleural fluid, a new position of the foreign body *et cetera*.

#### TREATMENT.

The treatment of thoracic foreign bodies differs very greatly according to the stage of recovery from the initial injury.

##### Immediate Treatment.

Immediate treatment does not come directly within the scope of this paper, since all the patients referred to here were observed and treated at a base hospital. Certain conclusions, however, may be drawn regarding the early management, partly from observation of the results in these cases and also from consideration of cases observed by the writer in the field.

It cannot be emphasized too strongly that the early treatment should be resuscitation and maintenance of the condition of the patient and the treatment of the complications which in themselves threaten life. The most important of these is the "sucking" wound, which should be sutured.

The reasons for limiting interference are that all the facilities, some of them essential, cannot be applied adequately in the field; transport of the individual not only in itself militates against his chance of recovery, but adequate post-operative care, particularly such as negative-pressure drainage, cannot be applied in ambulances, on ambulance trains *et cetera*. In addition it is undesirable that the patient subjected to such treatment should pass through many hands, especially as it requires specially skilled personnel for its satisfactory management.

The writer feels most strongly that the attitude that the operation is all important is the antithesis of the truth. The essential feature is the after-treatment. If this is inadequate, then the operation is of no avail. To speak of performing lobectomy *et cetera* in the field argues a complete lack of

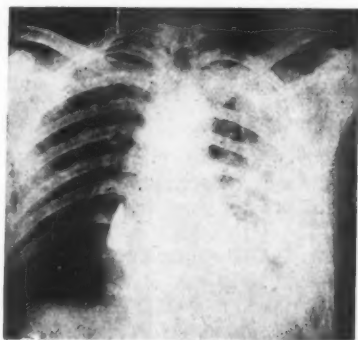


FIGURE VA. Antero-posterior view.

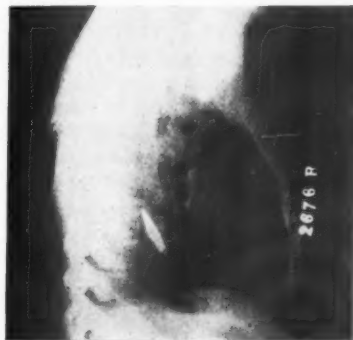


FIGURE VB. Lateral view.

Figures VA and VB are skiagrams showing the foreign body (machine gun bullet) in the posterior mediastinum. Case XI.

perspective. To those seriously interested in thoracic surgery this may seem unnecessarily discursive, but experience suggests that it is not completely misplaced.

In summary, therefore, the immediate treatment of thoracic wounds consists of the minimum of interference which will allow the patient to arrive at some place where he can be treated and nursed for a considerable period. That this ideal may be departed from, owing to military exigencies, goes without saying and need not be discussed beyond stating that every possible effort should be made to attain the ideal. Should suitable accommodation and facilities be available near a front line (as has occurred), then that is to the advantage of all.

#### Late Treatment.

The late treatment of foreign bodies in the chest resolves itself into that of two main groups: (i) removal of a foreign body which is apparently uncomplicated; (ii) treatment of cases in which obvious complications are still present.

The question of the desirability of removal of a foreign body which is not obviously causing trouble, has been mentioned already. In a general way it may be considered that, by analogy with foreign bodies elsewhere, the

elimination of the missile is desirable, provided that the risks of removal are not unreasonably great. The cases discussed here indicate that such removal is justified, especially in view of the fact that in several of them potential complications were present (in the form of clinically latent infection).

Such removal should be undertaken when the condition of the patient is sufficiently good for him to withstand easily the operative interference with a minimum of risk and disability. This usually means that there should have been an interval of from three to eight weeks between the time of the wound and the operation. This time will depend on the severity of the original wound, the presence of associated injuries, the rate of recovery from the original hæmopneumothorax and the presence of infection (in any part of the body).

The average time in the cases in this series was just over five weeks. This was not entirely a matter of choice or judgement, since some patients were delayed in transport to the base hospital, being held for periods at intermediate hospitals. Two patients developed dysentery and operation was delayed on this account. The shortest time was three weeks and the longest, in two cases, was eleven weeks.

The size of the missile may influence a decision to remove it. Small foreign bodies may be left *in situ*, but should be observed carefully for a time as, in this series, it was the smaller foreign bodies that were associated with abscesses.

Treatment of abscess or empyema away from the missile does not require any special discussion. When such a condition is associated with the foreign body it goes without saying that it is desirable to remove the latter at the same time as the pus collection is dealt with. Other conditions, such as persistent effusions, require no special comment. At times other injuries may, for a time, take precedence over the thoracic condition.

#### *Method of Approach.*

The method of approach will depend entirely on the location of the projectile. The approach should be the shortest possible. Mediastinal foreign bodies should be approached retropleurally, though it may be noted that in both the cases described here the missile was partly in the pleura or so firmly attached to it that the pleura tore as it was being removed. At this stage of the operation, however, this is of but little consequence.

The anterior approach is made by reflexion of appropriate costal cartilages. Approach to the posterior mediastinum is obtained by resection of portion of two or more ribs between the angles and the vertebral transverse processes.

The approach to pulmonary foreign bodies depends on the presence of adhesions. When adhesions are numerous and strong, direct approach is made and with remarkably little disturbance to the patient. When there are no adhesions the lung is made to collapse by artificial pneumothorax, open thoracotomy is performed and the foreign body is removed from the collapsed lung. It should be stated that the piece of metal, particularly when small, could be discovered very expeditiously and easily in these cases.

Approach to the anterior part of the lung is obtained by incision of three costal cartilages, incision along an intercostal space (below the last costal cartilage severed), followed by reflexion of the flap so formed. The posterior part of the lung is demonstrated through an intercostal incision, adequate room being obtained by cutting the posterior ends of the ribs on one or both sides of the incision.

The pleural foreign bodies presented no special difficulties.



### *Pre-Operative Treatment.*

Special attention before operation to the general condition of the patient is necessary. He has probably been for a period without adequate variety of food, has had insufficient sleep and the early part of his convalescence may have occurred in most trying circumstances.

Sufficient sedation, particularly if he is in an area where bombing or air raids occur, is imperative. There is no doubt that this makes a very great difference to the rate of improvement in the general condition. The inclusion of fresh food in the diet is a valuable adjunct.

The active treatment of a residual anæmia is important. In one case (Case I) the development of a post-operative empyema was associated with such a state and might conceivably have been avoided had more care been given to this point.

In the appropriate cases artificial pneumothorax is induced. In some this may be found to be impossible on account of adhesions, while in others consideration of the site of the missile or damage to adjacent ribs *et cetera* may indicate that it is unnecessary.

In suitable cases its advantages are great:

1. The disturbances of operation—the necessarily sudden readjustments in blood distribution and the diminution in vital capacity—throw an undue strain on the individual. There is no doubt that thoracotomy, when collapse of the lung has already been caused, is a procedure associated with little shock. There is a much easier post-operative period which greatly diminishes the demands on what is often an overworked staff. This also means less anxiety to the surgeon—an important point when he has a large number of sick patients under his care.

2. There is much less likelihood of mediastinal flap and thus the operation may be carried out in much greater comfort. Several of the patients in this series were operated on with ease, the only assistant being the theatre sister. This ease of procedure and absence of disturbance also reflect themselves in the bland post-operative course.

3. When the lung is collapsed and relatively motionless it is a very easy matter to find even a small foreign body. In only one case was it not found (Case II), and here the missile was deep in the hilum, and an object of the same size and shape and lying in the region shown in the X-ray film was removed; this was recognized as a piece of bone, but no other foreign body could be palpated with certainty. In the other cases the ease of finding the missile allowed of its removal within one or two minutes of entering the chest.

4. The amount of bleeding, after incision of the collapsed lung, was very slight. There was a considerable difference between these cases and those in which the object was removed from expanded lung.

### *Operation.*

The anæsthetic of choice depends on several factors, but in this series local anæsthesia was employed in all. In those in which the pleura was opened unexpectedly or when adhesions proved less numerous than had been anticipated, some degree of positive pressure inhalation (oxygen only or nitrous oxide and oxygen) was given. This was administered by an endotracheal tube or by means of a tightly fitting mask. Gas and oxygen were given also in three cases where the patients were of a nervous disposition.

The position of the patient was such as to allow easy approach to the affected part. The two common positions were dorsal decubitus and the lateral position.



Only those cases in which the foreign body lay deep in the lung and in which absence or paucity of adhesions allowed preliminary pneumothorax (Cases I, II, III, IV and V) need be discussed. As soon as the chest was opened adequately (see above), the lung, lying on the mediastinum, was palpated and drawn towards the wound. The foreign body could be felt immediately. When a few adhesions were present it was found best to divide them at the outset. This applied even when the foreign body lay in a part of the lung held out by an adhesion.

That aspect of the lobe nearest to the missile was then determined. Incision of the lung was then made over the foreign body and it was removed. The incised area was then sutured, excess fluid removed and the chest closed. A drainage tube was inserted either through the wound or through a stab wound in an intercostal space posteriorly.

The only operative complication was a brisk hæmorrhage immediately following removal of an (irregular) missile from the left lower lobe (Case V). This seemed to be due to tearing of a large branch of the pulmonary artery as the foreign body was extracted. It seemed probable that the metallic fragment was partly in the vessel wall. Sutures controlled the bleeding and no further trouble ensued.

#### *Post-Operative Treatment.*

Post-operative treatment consisted of sedation, intravenous therapy, oxygen therapy and drainage of the pleural cavity.

1. Thorough sedation was of great importance. The less satisfactory convalescence of those who, for one of several reasons, failed to receive their sedatives was sufficiently striking to convince previously sceptical observers.

2. Continuous intravenous therapy was necessary more because of weather conditions than because it was otherwise imperative. Such administration is advantageous in that it allows patients to rest without having to be disturbed to be given fluids frequently by mouth, and in a few cases in which there was some gastric disturbance, complete alimentary canal rest was easily obtained.

3. Oxygen therapy was given only in two cases—in Case XI (mediastinal foreign body with anaerobic infection) in which the patient was desperately ill, and Case V in which the patient developed a post-operative pneumonia on the fourth day.

4. Negative pressure drainage was instituted in all cases in which the pleura was opened widely and in Case XI. The pressure employed was that of five inches of water in the manometer on the first day, gradually increased to that of twelve inches to fifteen inches on the third.

The drainage (of blood-stained fluid) was: in the first twenty-four hours from 100 to 600 cubic centimetres, in the second twenty-four hours 50 to 200 cubic centimetres, and in the third twenty-four hours nil to 50 cubic centimetres. The drainage tube was removed on either the third or fourth day, depending on the amount of drainage.

Expansion of the lung was good, but it is noteworthy that a residual apical pneumothorax remained (being gradually absorbed in the succeeding ten days) in those cases in which an incision was made in the upper lobe. This was in such contrast to what happened in conditions such as diaphragmatic hernia (in which the lung was not incised) that it was decided that removal of the air on the third or fourth day should be an integral part of the management. This has been carried out so far in only two cases.

### Post-Operative Complications.

Four complications were observed.

1. Infection of the wound, in each case of mild degree and not influencing the time of convalescence, occurred in three cases. This was attributed to general working conditions and did not have any particular bearing on the specific nature of the procedures.

2. Post-operative empyema occurred once (Case I) and was treated by negative-pressure drainage through a stab intercostal incision. The tube was removed in eleven days and the wound healed in fourteen days. There had been a pulmonary abscess, and the development of the empyema was regarded as being, at least in part, related to this.

3. Chondritis of the costal cartilages (at site of incision) occurred in one patient (Case II). There were no constitutional ill-effects, but convalescence was delayed for two months.

4. Post-operative pneumonia occurred once (Case V), developing on the fourth day. Sulphapyridine was administered and crisis occurred in forty-eight hours.

### Late Treatment.

The essential point at this stage is reeducation of the thoracic musculature. There is always a gross limitation of movement on the affected side, and exercises should be begun as soon as the temperature approaches normal and discomfort allows of reasonable effort. This is usually within a week of operation. Exercises such as swimming are allowed as soon as the wound is healed.

### General Post-Operative Course.

The patients with pulmonary conditions were transferred to convalescent depot as soon as they were fit to travel. After a period of about four weeks they were returned to hospital, where they were observed and given exercises and a short gymnasium course. They were then returned to duty. The average time (from operation to return to duty) was nine weeks.

The other patients did not require prolonged treatment and were returned to duty on an average of three weeks. The patient with the posterior mediastinal foreign body (Case XI) was much slower in recovering (owing to associated anaerobic infection) and is not included amongst these. He is, at the time of writing, well.

### SUMMARY.

1. A series of twelve cases of thoracic foreign bodies is described.
2. These were consecutive cases observed at an Australian general hospital.
3. Removal of the foreign bodies was undertaken and the results are described.

ADDENDUM.

Since the above was written a further series of ten consecutive patients, these being consecutive with the above, have been treated.

The foreign bodies all consisted of shell or bomb fragments. Three were over one inch long and over half an inch wide; one other was an inch square. They were from three-sixteenths to one-quarter of an inch thick. The remainder were of the same order as the ones described above.


They were situated as follows:

[illegible]

A bacterial culture (similar to those obtained in the first series) was obtained in six cases. In three cases pieces of tunic (or similar material) were found and these gave the most profuse growth.

Two of the patients did not arrive for treatment for a considerable period after being wounded; in one case the interval was nine months and in the other four months. The former had developed hæmoptyses and the second, after feeling well for about three months, developed pain in the chest over the site of the missile, malaise and cough. These cases support the contention of the desirability of removal of the foreign bodies.

Post-operative complications consisted of infection of the wound in three cases and, in one of these, an empyema. These complications occurred in those cases in which the most profuse bacterial growth was obtained from the foreign bodies.



# ACTINOMYCOSIS OF THE URINARY SYSTEM.<sup>1</sup>

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## WITH A SUPPLEMENTARY ARTICLE ON AN ASSOCIATED INFECTION OF THE LIVER.

By D. A. WELSH,  
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(Continued from page 226.)

### TREATMENT OF ACTINOMYCOSIS IN THE URINARY SYSTEM.

WHEN the problem of the treatment of a definitely diagnosed actinomycotic lesion in any part of the urinary system is considered, it is necessary to ascertain, if possible, whether there is another small or large focus of infection in any other region of the body and especially in the liver.

In actinomycotic lesions of the kidney, even if X-ray examinations of other regions give completely negative results and the remaining kidney is apparently healthy, a test of hepatic function should always be made before an operation is performed, and particularly so when the pathological process is apparently limited to the right kidney. Surgical, physical and medical therapy has been used and frequently a combination of two or more forms of therapy has been tried with varying results.

The weight of authority in cases of renal actinomycosis in which the lesion is apparently limited to one kidney is in favour of total nephrectomy followed by medical treatment, particularly the oral administration of potassium iodide.

It must be remembered that the incision must be of ample length and that all the surrounding tissues and particularly the kidney itself must be handled gently and the blood vessels must be ligated or clamped early, so as to lessen the possibility of extension of the infection by the renal veins. One must be particularly careful to use another knife when making a stab wound for the purpose of inserting drainage material. Personal experience with a limited and apparently isolated lesion in the pelvis which was followed by a secondary lesion in the stab wound, compels me to give this warning.

Palliative surgical measures such as drainage of a perirenal abscess sometimes of necessity precedes radical surgical treatment; in fact, the correct diagnosis is often made only after this operation has been performed. Various local therapeutic applications to the wound after operation have been suggested, such as lavage with peroxide of hydrogen or with tincture of iodine, packing with iodoform gauze *et cetera*.

X-ray therapy and oral medical treatment with one or more of the drugs mentioned in previous articles have also been recommended. In available literature one searches in vain to find an article which gives the method of application and details of the X-ray treatment to be used either before or after operation has been performed on an apparently unilateral and isolated renal lesion. X-ray therapy in pelvic actinomycotic lesions in which the bladder is involved has already been described.<sup>(126)</sup>

One hesitates to enter into the controversy waged in the *British Medical Journal* on the antiseptic or curative value of hexamine in infections of the kidneys. It is, however, suggested that in apparently isolated actinomycotic renal infection which has failed to respond to a favourite therapy or a combination of therapeutic agents, "the kindness of Nature" may sometimes be aided by the prolonged oral administration of hexamine before meals.

#### CASE REPORTS.

##### *Case I. Bilateral "Excretory" Actinomycosis.*

Mrs. E.P., whose early history has been reported in a previous article,<sup>(129)</sup> was seen on January 28, 1921, and had suffered from attacks of vomiting and headache for seven years, and for the previous eight days had noticed blood in her urine and had also complained of a constant severe aching pain in the right lumbar region. When she was about six months pregnant with her second child, twelve years previously, she had noticed that the urine contained blood, and continued to be tinged with blood on each occasion she voided urine for about eight weeks. Her nurse attributed the hæmaturia to the "effects of her pregnancy". In September, 1920, blood again appeared in the urine for a period of three days and clots of blood were noticed particularly at the end of micturition. On this occasion she had suffered dull pain in the right lumbar region for two days previous to the appearance of hæmaturia and found that the pain was relieved by the recumbent position. She had not experienced pain or noticed any frequency in micturition at any time and only during an attack of hæmaturia was she compelled to urinate once and sometimes twice at night.

Examination of the urine showed the specific gravity to be 1.018; a trace of albumin was present; there was no sugar in the urine; there were on an average 120 erythrocytes in each microscopic field, and neither casts, crystals nor organisms were found. The erythrocytes numbered 4,000,000, the leucocytes 7,800 per cubic millimetre. The hæmoglobin value was 80%. The polymorphonuclear cells numbered 72%, lymphocytes 24%, large mononuclear cells 3%, and eosinophile cells 1%. Her blood and cerebro-spinal fluid yielded no reaction to the Wassermann test. Her systolic blood pressure registered 136 millimetres of mercury and her diastolic pressure 80 millimetres.

Cystoscopy and retrograde pyelography revealed no abnormality of the bladder, ureters or kidneys. Erythrocytes were not found in the urine on the fourth or subsequent days during three weeks' observation in hospital.

Microscopic examinations were made of the urine at mid-menstrual monthly periods and occasionally during menstruation until May, 1924. Thirty erythrocytes were found in each microscopic field on one occasion only (December 6, 1922). Her last menstrual period occurred in June, 1924, and she has not menstruated since.

From June, 1924, she reported at bimonthly intervals until June, 1925, when she stated that she had been enjoying good health, and was heavier in weight than she had ever been. At that time she decided to discontinue treatment with potassium iodide, which had been prescribed when she was leaving hospital in 1921.

She did not report again until November 2, 1929, when she complained of a recurrence of continuous aching pain in the right lumbar region for the previous seven days; of difficulty in commencing micturition; of severe pain in voiding urine for the previous five days, which was worse at the commencement of the act; of frequency of micturition and of a yellow vaginal discharge. She had noticed her urine to be blood stained for three days and to have a peculiar odour, which she attributed to some "funny black and yellow grains" in the urine.

On inquiry, I found that she had enjoyed apparently good health until December, 1927, since when at periods ranging from eight to seventeen weeks she had complained of pain in the right lumbar region, colicky in nature, which occasionally radiated to the right inguinal region and was aggravated by exertion and relieved by resting in bed and was accompanied by hæmaturia. Small clots of blood were sometimes passed in her urine at the end of micturition. On two occasions she had also noticed in her urine "nasty black grains", each about the size of a grain of sago. The yellow vaginal discharge had been present almost continuously for three months and was becoming offensive. These attacks made her feel "weak and miserable", and occasionally necessitated her confinement to bed for three to four days. She was always impressed with the manner in which each attack passed off. "I would get up in the morning after an uncomfortable night and be free of pain as if by magic and no blood could be seen in my urine."

From early in May, 1921, until November 2, 1929, she had not vomited or suffered from headache, except on two occasions on which the headache was of short duration and did not even necessitate the use of sedatives.

Until five days previously she did not suffer from frequency of micturition and had not experienced any pain before, during or after micturition. The pain which accompanied micturition had gradually increased in severity and on the day before her visit was accompanied by tenesmus. The pain was most severe at the commencement and end of micturition, particularly the former. During the previous five days she had been compelled to pass urine almost every half hour during the day and also at night. She had gained at least eight pounds in weight since June, 1925.

Dread of cystoscopic and X-ray examinations had caused her to neglect to report the recurrence of hæmaturia. On examination she appeared to be a well nourished woman; she had a temperature of 98·6° F. and a pulse rate of 82. Slight tenderness was elicited on palpation of the abdominal wall above the *symphysis pubis* and on palpation of both kidneys, particularly posteriorly in the right lumbar region. Neither kidney appeared to be increased in size, and there was no fixation of the skin or subcutaneous tissues to underlying structures in the region of the kidneys or bladder. Clinical examination of the nervous, respiratory, circulatory and alimentary systems revealed no abnormality. The vaginal walls and outlet were found to be slightly relaxed, the body of the uterus was situated anteriorly and the cervix was found to be slightly eroded. The inguinal glands were not enlarged. She was admitted to hospital on the day of her visit. The symptoms and signs of her illness improved rapidly after two days' rest in bed.

Blood examination was made on November 4, 1929. The erythrocytes numbered 4,000,000, the leucocytes 7,200 per cubic millimetre. The hæmoglobin value was 70%. The polymorphonuclear cells numbered 66%, lymphocytes 28%, large mononuclear cells 4% and eosinophilic cells 2%. Her blood yielded no reaction to the Wassermann test.

Urea concentration test, November 6, 1929, gave the following results:

*Specimen A: Before taking urea.*

|                  |                       |
|------------------|-----------------------|
| Area             | 2.8%                  |
| Amount           | 184 cubic centimetres |
| Specific gravity | 1.025                 |
| Reaction         | Acid                  |
| Albumin          | Faint trace           |
| Sugar            | Nil                   |

Numerous calcium oxalate crystals, an average of twelve erythrocytes in each microscopic field, small colonies consisting of a radiating feltwork of mycelial filaments showing true branches with terminal distensions and no casts were seen on microscopic examination of the centrifugalized deposit of urine. Subsequent cultures from the specimen of urine also revealed the presence of a very few colonies of staphylococci.

*Specimen B:* One hour after taking urea.

|                  |         |                       |
|------------------|---------|-----------------------|
| Urea             | .. .. . | 2.4%                  |
| Amount           | .. .. . | 105 cubic centimetres |
| Specific gravity | .. .. . | 1.017                 |
| Albumin          | .. .. . | Faint trace           |

*Specimen C*: Two hours after taking urea.

|                  |                      |
|------------------|----------------------|
| Urea             | 2.6%                 |
| Amount           | 40 cubic centimetres |
| Specific gravity | 1.017                |
| Albumin          | Faint trace          |

*Specimen D: Three hours after taking urea.*

|                  |         |                      |
|------------------|---------|----------------------|
| Urea             | .. .. . | 2·6%                 |
| Amount           | .. .. . | 47 cubic centimetres |
| Specific gravity | .. .. . | 1·017                |
| Albumin          | .. .. . | Faint trace          |

Blood urea estimation revealed twenty-eight milligrammes per 100 cubic centimetres of blood. X-ray examination of the lungs and osseous system revealed no abnormality.

Cystoscopic examination on November 7, 1929, showed that the bladder was not contracted and the mucous membrane of the lateral walls of the bladder was normal in appearance, but the whole of the trigone and lowermost portion of the adjacent bladder wall were covered with granules of varying size and colour. The striking feature of the cystoscopic picture was the accumulation of at least twenty "sulphur" granules near the orifice of each ureter. These "sulphur" granules were present only in these two areas. Indigo-carmine was excreted in good concentration from the left ureteral orifice in six minutes and from the right side in seven minutes. Actinomyces colonies were found on microscopic examination of four specimens of urine obtained from the pelvis of each kidney by ureteral catheterization. The pyelo-ureterograms on both sides showed a "moth-eaten" appearance of the ureter (see Figure I).

Microscopic preparations and tubes of media inoculated with material obtained from the cervix and vagina failed to show the presence of the organism of actinomycosis.

When the correct diagnosis of her illness was made a further detailed history of her past life and habits was obtained. She had spent her girlhood in a rural district outside Bathurst, New South Wales. Until she attained the age of thirty years, she was in the habit of biting her nails and found difficulty to abstain from the habit even



at the time of examination. On the advice of a physician she had worn a pessary "to support her womb", soon after her headaches commenced, but discontinued using it as it did not give the promised relief. She had not used contraceptives or vaginal douches, and beyond a sterile catheter introduced for the purpose of urine examination and a cystoscopic examination in 1921 no foreign body had entered her bladder. Her upper teeth, which were badly decayed, were extracted when she was twenty-one years of age. The mucosa was slow to heal; the lower teeth were removed for the same cause seven years later, when the mucosa healed readily.

The patient could not be enticed to stay in hospital on account of the illness of one of the members of her family, and she was given a mixture containing 1.2 grammes (20 grains) of potassium iodide, which she continued to take three times a day until her readmission on January 13, 1930.

Table I shows date, quantity of urine excreted and local treatment until February 13, 1930.

Four cystoscopic examinations and two X-ray examinations were made during her stay in hospital. Beyond a rise in temperature to 101.2° F., gradually subsiding in thirty-six hours after the first cystoscopic examination, and 101.6° F., subsiding in forty-eight hours after the second examination, her temperature had not risen above 99° F. during her stay in hospital.

At the last cystoscopic examination only twenty-three sulphur coloured granules were seen in the bladder, fourteen of which were situated near the orifice of the right ureter, and nine near the opening of the left ureter. The "moth-eaten" appearance of the left ureter had disappeared. The right ureter showed slight evidence of its former appearance in an area three centimetres long, the centre of which was situated about eight centimetres below the pelvis of the kidney. The cystoscopic examinations revealed that the silvery translucent bodies disappeared early in the treatment, then the grey and brown bodies, and then the black bodies, leaving the sulphur coloured bodies seen at the last examination, thus indicating the possibility of the translucent bodies being young and more susceptible to treatment than the grey, brown and black bodies, which are in turn apparently more susceptible to treatment than the older and more resistant sulphur coloured bodies.

Four further cystoscopic examinations were made at intervals of eight weeks, and these sulphur bodies, although reduced slightly in size, were still present at the last



FIGURE 1. Case I. Pyelo-ureterogram showing "moth-eaten" appearance of right ureter.



examination, and it was not until iodide treatment by mouth was discontinued and "Hexsotate" administered orally in doses of 0.9 gramme (fifteen grains) three times daily that these bodies completely disappeared, and they were not seen at a cystoscopic examination late in March, 1931.

Treatment with hexamine or "Hexsotate" was continued until June, 1932.

X-ray and cystoscopic examinations and examination of the urine in October, 1933, showed no evidence of actinomycotic infection of the kidneys or bladder.

She was again examined on March 6, 1936, when she mentioned that she had been treated for biliary colic one month previously. Examination of her urine again revealed no abnormality. Graham's test showed the presence of numerous shadows, probably calculi, in the region of the gall-bladder.

Cholecystectomy was performed in August, 1940. The great omentum was adherent to the fundus of the gall-bladder. Microscopic examination of the wall of the gall-bladder showed it to be considerably thickened and densely fibrous. There was a dense

TABLE I.

| Date.   | Quantity of Urine. | Treatment Insillation into the Bladder.   |
|---------|--------------------|---|
| 14.1.30 | 55 ounces          | 2 ounces of 12½% sodium iodide once daily and retained for one hour or longer.  |
| 15.1.30 | 38 ounces          | 2 ounces of 12½% sodium iodide once daily and retained for one hour or longer.  |
| 16.1.30 | 40 ounces          | 2 ounces of 12½% sodium iodide once daily and retained for one hour or longer.  |
| 17.1.30 | 40 ounces          | 2 ounces of 12½% sodium iodide once daily and retained for one hour or longer.  |
| 18.1.30 | 38 ounces          | 2 ounces of 12½% sodium iodide once daily and retained for one hour or longer.  |
| 19.1.30 | 35 ounces          | 1 drachm of hydrogen peroxide in 5 ounces of distilled water once daily.  |
| 20.1.30 | 36 ounces          | 1½ drachms of hydrogen peroxide in 5 ounces of distilled water once daily.  |
| 21.1.30 | 40 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 22.1.30 | 34 ounces          | On account of severe pain in left lumbar region reduced to 1½ drachms of hydrogen peroxide in 4 ounces of distilled water once daily. |
| 23.1.30 | 45 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water once daily.  |
| 24.1.30 | 46 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water once daily.  |
| 25.1.30 | 41 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water once daily.  |
| 26.1.30 | 28 ounces*         | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 27.1.30 | 32 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 28.1.30 | 34 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 29.1.30 | 37 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 30.1.30 | 36 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 31.1.30 | 41 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 1.2.30  | 42 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 2.2.30  | 42 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 3.2.30  | 50 ounces          | 1½ drachms of hydrogen peroxide in 4 ounces of distilled water twice daily.   |
| 4.2.30  | 36 ounces*         | 1½ drachms of hydrogen peroxide in 3 ounces of distilled water twice daily.   |
| 5.2.30  | 20 ounces*         | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 6.2.30  | 30 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 7.2.30  | 35 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 8.2.30  | 31 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 9.2.30  | 37 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 10.2.30 | 28 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 11.2.30 | 44 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 12.2.30 | 44 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 13.2.30 | 46 ounces          | 2 drachms of hydrogen peroxide in 2 ounces of distilled water twice daily.  |
| 14.2.30 |                    | Discharged at her own request after cystoscopic examination.  |

\* Perspiration free.

submucous infiltration of small round cells and these were also present in considerable masses between the bundles of collagen fibres in the deeper parts of the wall. The omentum at the point at which it was attached to the gall-bladder was undergoing fibrous transformation.

Examination of numerous sections of the gall-bladder wall and of the calculi failed to disclose the presence of the organism of actinomycosis. Pyelograms and cystoscopic examination revealed no abnormality.

### *Case II. Ascending Infection of the Kidney.*

Mrs. A.E., aged thirty-nine years, the mother of two healthy children, fourteen and ten years of age respectively, had suffered from chorea at six years of age, scarlet fever at twelve and influenza at twenty-seven; and on February 19, 1929, consulted me on account of frequent and painful micturition and an offensive thick white discharge from the orifice of the urethra which sometimes contained "bright yellow specks and black things like nose dirt", and which commenced about ten months previously and was gradually becoming more copious and more offensive, and for the previous three months necessitating the continuous use of diapers. She had been compelled to rest in bed for the previous three weeks, as she experienced considerable discomfort and pain in attempting to walk even a short distance largely due to the irritation caused by the moist diapers.

About the middle of July, 1928, she developed "pain and soreness" in the right inguinal region which caused her to seek medical advice, as she believed the inflammatory condition in her urethra was possibly extending to her ovary.

After several days' observation in hospital, during which time cystoscopic, X-ray and other examinations were made, laparotomy was performed and a small cystic right ovary was removed. The operation wound healed in fourteen days, but she remained in hospital for nine weeks in order to allow further investigations to be made. Pyelograms obtained before she was discharged from hospital did not reveal the presence of a lesion in the right kidney.

During her stay in hospital the pain in the right inguinal region disappeared and has not since recurred. She experienced pain in commencing micturition shortly after her discharge from hospital and about the same time noticed that she commenced to void urine more frequently than usual. The disturbances of micturition gradually became worse, and for the previous week she was compelled to rise at least ten times each night and during the day she experienced great difficulty in retaining her urine for longer than a period of one hour. She had lost almost 6.3 kilograms (one stone) in weight during the previous twelve months. A doctor who was present at the operation informed me that the surgeon had suspected an abscess in the prevesical space. No evidence of periostitis or osteomyelitis nor any evidence of an inflammatory condition was found in the prevesical space. The pathological process appeared to be limited to the urethra. Cystoscopic examination at the time of operation did not reveal any abnormal condition in the bladder. No palpable pathological condition was observed in either kidney, in the pelvic portion of the ureters, bladder, intestine, or in the remaining genital organs.

Physical examination in February, 1929, failed to reveal any other condition except a urethritis which did not appear to be associated with the presence of a calculus or a foreign body. Microscopic examination of the urethral discharge revealed the presence of mixed infection.

Hospital treatment and further investigation was advised but refused by the patient. As the prescribed treatment did not afford complete relief, she consulted a herbalist and several chemists.

The local treatment prescribed by the last consulting chemist she visited aggravated the urethral discharge and caused her to consult me again on July 17, 1930. At this time micturition was much less frequent and also less painful than on the previous visit. She had suffered from a dull pain in the right lumbar region for the previous two days, which was relieved by the recumbent position. Three sulphur coloured bodies, subsequently proved to be actinomyces granules, were found attached to the mucous membrane of the external orifice of the urethra. Actinomyces granules were also found in the discharge which was expressed on the application of pressure to the indurated urethra. A definite indurated band continuous with the indurated urethra was palpated on vaginal examination and was continuous with an infiltrated strand in the region of the lower end of the right ureter.

Her menstrual history and a pelvic examination did not suggest involvement of the internal genital organs.

Further inquiry after her admission to hospital on the following day elicited the additional information that she had not used contraceptives or vaginal douches and also that her husband had not suffered at any time from any penile discharge, sore or erosion. The teeth in her upper jaw were extracted when she was seventeen years of age

and the mucosa healed readily. Six carious teeth had also been removed from her lower jaw on five occasions previous to 1925, and the extractions apparently had not been followed by any complications.

Her blood yielded no reaction to the Wassermann test. The erythrocytes numbered 4,210,000, the leucocytes 9,600 per cubic millimetre. The hæmoglobin value was 84%. The polymorphonuclear cells numbered 66%, small lymphocytes 30%, large lymphocytes 2%, large mononuclear cells 1% and eosinophile cells 1%.

The urea concentration test was performed with the following results.

*Specimen A: Before taking urea.*

|                  |                       |
|------------------|-----------------------|
| Urea             | 2.6%                  |
| Amount           | 210 cubic centimetres |
| Specific gravity | 1.010                 |
| Reaction         | Acid                  |
| Albumin          | Cloud                 |
| Sugar            | Nil                   |
| Acetone          | Nil                   |

Numerous pus cells, erythrocytes, actinomyces colonies, some motile organisms and an occasional granular cast were found on microscopic examination of the urine.

*Specimen B: One hour after taking urea.*

|                  |                      |
|------------------|----------------------|
| Urea             | 1.8%                 |
| Amount           | 32 cubic centimetres |
| Specific gravity | 1.015                |
| Albumin          | Trace                |

*Specimen C: Two hours after taking urea.*

|                  |                       |
|------------------|-----------------------|
| Urea             | 3.4%                  |
| Amount           | 110 cubic centimetres |
| Specific gravity | 1.015                 |
| Albumin          | Trace                 |

*Specimen D: Three hours after taking urea.*

|                  |                      |
|------------------|----------------------|
| Urea             | 3.6%                 |
| Amount           | 48 cubic centimetres |
| Specific gravity | 1.015                |
| Albumin          | Trace                |

Blood urea estimation showed 30 milligrammes per hundred cubic centimetres of blood.

X-ray examinations of the lungs, lumbar vertebræ, pelvis and upper extremity of each femur did not reveal evidence of any inflammatory process.

Two inflammatory strictures, which were possibly aggravated by trauma produced by previous attempts at catheterization and cystoscopic examinations, were found in the urethra. A fistula 1.5 centimetres long, which communicated with the lumen, was found on the right lateral wall of the urethra. The urethral mucous membrane near the internal orifice of the urethra showed no changes except a slaty grey discoloration on its ventral aspect, which continued through the trigone directly to the orifice of the right ureter as a definite raised band about a centimetre wide and which was almost black in its centre. Beyond this definitely raised band and a slight reddening of the right ureteral orifice and adjacent mucous membrane of the trigone, nothing else abnormal was observed on cystoscopic examination.

Slight hydronephrotic changes in the calyces of the left kidney and in the calyces of the lower pelvis of the right kidney and a "moth-eaten" appearance of the lower portion of the right ureter were observed on examination of pyelo-ureterograms obtained after the introduction of ureteral catheters (Figure II). Indigo-carmin was excreted in good concentration from the left kidney in seven minutes and from the right in eight minutes.

Microscopic examination failed to reveal the presence of actinomyces colonies in specimens of urine obtained by ureteral catheterization of the right kidney on four different occasions, and it was only on the fifth examination (November 6, 1930) that the ureteral catheter entered the upper pelvis of the right kidney and actinomyces colonies were found on microscopic examination of four specimens of urine obtained at that examination.

Signs and symptoms developed shortly after this examination which led two consultants and myself to believe that urine or actinomycotic material was being extravasated into the surrounding tissues in the neighbourhood of the kidney. At operation on the following day no evidence of such a catastrophe was found. An indurated ureter, almost two centimetres wide, was found to extend from the bladder to the upper pelvis of the kidney, which was also indurated. The supernumerary ureter leading from the lower pelvis of the kidney was apparently healthy. The upper pole of the kidney was occupied by a hard indurated mass, and the surrounding tissues in the immediate neighbourhood showed no macroscopic evidence of extension of the infection.

Numerous attempts were made to isolate the causal organism in pure culture without success.

Solutions of 12.5% sodium iodide and hydrogen peroxide were instilled into the bladder daily for three months and were commenced one month after the patient's admission to hospital. Of tincture of iodine (French Codex) 0.18 mil (three minims) was administered in milk by mouth three times daily after meals shortly after admission to hospital, and was increased by 0.12 mil (two minims) daily until one drachm was taken three times daily. This later dose was administered until April 1, 1931, when 0.6 gramme (ten grains) of "Hexsotate" was administered three times daily before meals until she was discharged from hospital on August 31, 1931. The treatment

was continued until May 1, 1933, when the dose was increased to 0.9 gramme (fifteen grains) three times daily until January 1, 1934, when the dose was reduced to 0.6 gramme (ten grains) and later (October 1, 1934) reduced to 0.3 gramme (five grains). Treatment was discontinued on June 1, 1935, when she was apparently well and her urine contained no abnormal constituent and was found to be sterile on incubation under aerobic, micro-aerophilic and anaerobic conditions.

After the patient left hospital cystoscopic examinations were made and pyelograms were obtained at about half-yearly intervals until January, 1935. The "moth-eaten" appearance of the ureter was not observed after January 5, 1933, on which date the radiologist reported the following result of an intravenous pyelogram:

"Left renal tract appears to be normal, though there is some delay in emptying of left kidney pelvis. Calyces large. Pelvis of right kidney large. Normal in outline. Right ureter normal in outline from the right kidney pelvis to the iliac crest. From its entrance into the bladder up to the point where it crosses the sacrum there is marked dilatation. It remains full for four hours after



FIGURE II. Case II. Pyelo-ureterogram showing involvement of upper pelvis of right kidney and "moth-eaten" appearance of ureter.

administration of the dye. At the end of two hours the outline of what appears to be the second ureter becomes visible on the skiagram. It begins midway between the eleventh and twelfth ribs and runs down medially to the other ureter to the level of the third lumbar vertebra, where its outline is lost. A junction between the two ureters was not noted. The time appearance and the fact that no pelvis is visible at the upper end of this second ureter would suggest that it fills by back pressure from the lower dilated half of the first ureter. This would mean that the upper portion of the right kidney is still not functioning."







were found in the abdominal cavity. The liver was enlarged and its right lobe was slightly adherent to the dome of the diaphragm and its nodulated surface resembled the surface of a liver containing metastatic carcinomatous deposits. The gall-bladder and bile ducts were healthy. A careful examination of the lumen and walls of the stomach and intestinal tract, particularly the caecum, failed to reveal the presence of any active actinomycotic lesion. The spleen was slightly enlarged and showed no evidence of infection. The left kidney was enlarged and congested, its capsule stripped without difficulty, and the kidney showed no evidence of actinomycotic infection. The uterus and the left tube and ovary were healthy.

Microscopic preparations and tubes of media, inoculated from portions of viscera in the abdomen (except the liver), bile, pericardial fluid, heart blood, tonsils, cervix, vagina, lymphatic glands and one small area of intensely congested lung tissue, failed to show the presence of the organism of actinomycosis.

Microscopic examination of numerous sections of the remaining small sharply demarcated area of lung tissue showed that the inflammatory exudate into the air cells and small bronchi was chiefly leucocytic (neutrophile polymorphonuclear cells). Neither actinomyces colonies nor actinomycetes were found in any of the sections of lung tissue which were examined. The liver was forwarded to Professor Emeritus D. A. Welsh for cytological and histological examination.

A STUDY OF THE SECONDARY INFECTION OF THE LIVER, ILLUSTRATING  
PORTAL VENOUS ACTINOMYCOTIC EMBOLISM, RESULTING IN  
EXTENSIVE PYLEPHLEBITIS WITH INFARCTION OF LIVER,  
GOING ON TO HEPATIC VENOUS ACTINOMYCOTIC  
EMBOLISM.

(D. A. Welsh.)

*The Clinico-Pathological Complex.*

The clinical history suggests that, prior to the secondary infection of the liver, there was both an enteral and a parenteral actinomycotic infection, of which the enteral was the primary. The enteral infection is indicated clinically by the first operation in February, 1930, when a ruptured appendix was removed. Several operations to ensure better drainage were later performed. A second major operation in July, 1930, revealed a probable parenteral infection (following the appendicular infection) in the form of an acutely inflamed right ovary and a "pus tube", which were removed. At the same time numerous enlarged lymph glands were felt in the omentum, but thought to be tuberculous. In all probability those glands were really actinomycotic owing to an enteral infection which at that time may have taken the form of indolent intestinal ulceration. A third major operation in December, 1930, revealed a definite parenteral infection of the right kidney, which was reduced to a granulomatous mass. At that last operation the liver was examined and appeared to be healthy.

Notwithstanding every care, the patient died in March, 1932, and the liver was then found to be secondarily infected with numerous small colonies of actinomyces, some of which proved to be within branches of the portal vein, thus definitely establishing some form of antecedent enteral infection (in addition to the parenteral infection of the right kidney). It was further established that at death the secondary embolic infection of the liver was still actively proceeding, because small colonies of actinomyces, with evidence of their recent arrival, were found in the lumen of no less than four different branches of the portal vein when one hundred serial sections of one block of liver tissue were examined under the microscope.

In addition to the primary enteral and later parenteral actinomycotic infections, and the secondary portal embolic infection of the liver, there was found at death a tertiary embolic infection on its way to the lungs. For in several serial sections of the same block of liver tissue one small colony of

the actinomyces could be demonstrated within a tributary of the hepatic vein. At autopsy, however, the lungs were reported to be healthy and free from actinomycotic infection, even when two small areas of lung tissue were examined under the microscope. That makes the finding of an actinomycotic colony in an hepatic vein all the more interesting, because it represents the very beginning of a tertiary pulmonary infection which had not yet reached a stage when it was recognizable in the lungs. (Compare Figure V.)

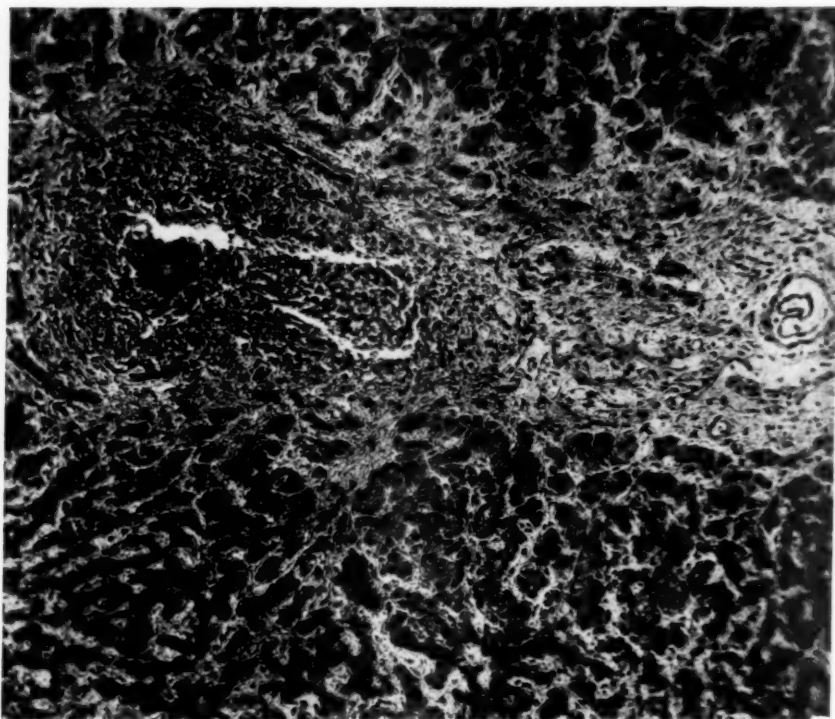


FIGURE III ( $\times 125$  circa). Portal venous actino-embolism with thrombophlebitis. A small, dark, densely felted colony of actinomycelial filaments has been carried into a small branch of the portal vein. The recent arrival of the actino-embolus is indicated by its small size and by the moderate attraction of neutrophile leucocytes around it within the vein. The small portal tract (cut somewhat obliquely) illustrates the effect of phlebitis in the form of a vigorous endothelial reaction going on to vascularization and canalization. The liver cells are not necrotic. An accidental precipitate of stain is seen below.

To sum up, therefore, this case illustrates: (i) concurrent enteral (primary) and parenteral actinomycotic infections of the alimentary tract and right kidney, (ii) a well established and still proceeding secondary embolic infection of the liver by way of the portal vein, and (iii) an incipient tertiary embolic infection of the hepatic vein on its way to the lungs.

#### *The Secondary Hepatic Infection.*

In order to study the pathology of the secondary hepatic infection, microscopic sections were prepared from several separate portions of the liver; but the chief interest centred in a block of liver tissue 3.0 centimetres

by 1.5 centimetres from which one hundred serial sections were cut and examined at frequent intervals. In this block on an average twenty colonies of the actinomyces were well scattered throughout each serial section, though more closely bunched towards one end, so that representative types of lesion were secured.

1. Each colony lay in a bed of leucocytes which formed a loculus enclosed by liver tissue reacting to the local toxic effect; and of course there appeared in each section portions of similar loculi from which the parasite was absent at that particular level.

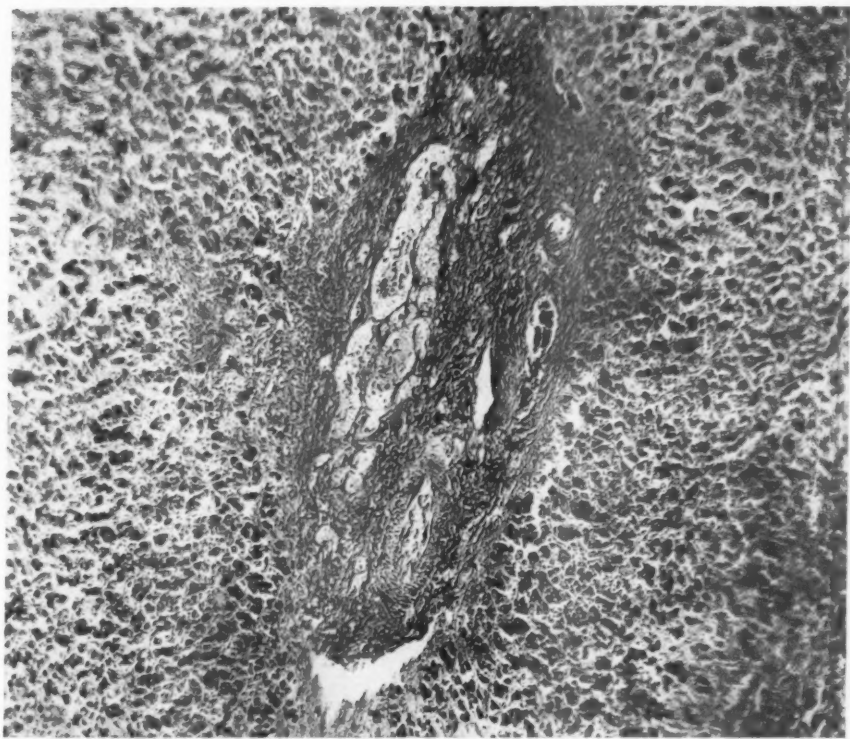


FIGURE IV ( $\times 100$ ). Complete and extensive necrosis (infarction) has overwhelmed a medium portal tract and all structures within it, together with the surrounding liver tissue. The portal vein has become obliterated by thrombophlebitis before necrosis set in. The hepatic artery is indistinct, but two small hyperchromatic branches of the bile duct can be seen.

2. The great majority of the portal veins were obliterated by secondary thrombosis and thrombophlebitis of a peculiar and varying type; and the hepatic artery in each portal tract was often larger and more prominent than usual, as if it was undergoing some form of compensatory hypertrophy.

3. Necrosis and necrobiosis had overtaken extensive areas of liver tissue *en masse*, including the portal tracts within the necrotic areas, and suggesting infarction of the liver from the multiple portal thrombosis and pyelephlebitis.

It is evident from those findings that the pathological picture unfolded by this case is much more interesting and intricate than the literature of hepatic actinomycosis would lead one to expect.

*Thrombosis and Thrombophlebitis of the Portal Veins.*

Widespread thrombosis and thrombophlebitis of branches of the portal vein within the substance of the liver was the first unexpected process to be encountered. And the first problem to be solved was how this process was

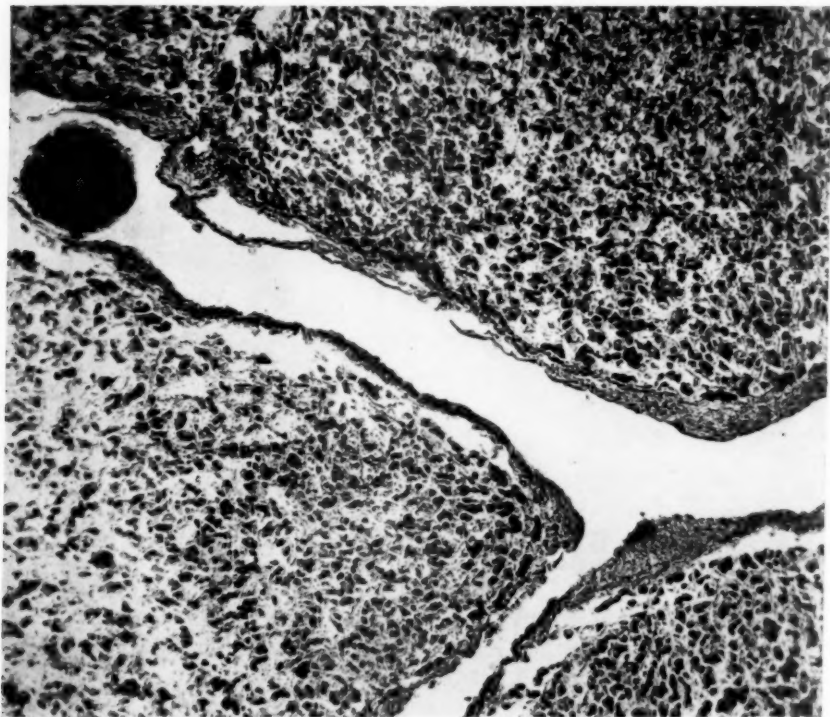


FIGURE V ( $\times 100$  circa). Hepatic venous actino-embolism. A small colony of the actinomyces, still entangling a few leucocytes around it, has entered a tributary of the hepatic vein as an embolus on its way to the lungs. The surrounding liver tissue is extensively necrobiotic from infarction.

brought about. For, while the great majority of the portal venous branches were obliterated by thrombophlebitis, there was no obvious cause within their portal tracts. Close study of the hundred serial sections, noted above, revealed a small actinomycotic colony in the lumen of four different venous branches, and thereby established the fact that portal venous embolism was the mode of infection.

In two of these branches the actinomyces formed a very tiny ball of mycelial filaments with a few extra leucocytes beginning to collect around it, the other contents of the vein being reduced to granular material, probably fibrin. In the other two branches the ball of parasitic threads was slightly larger, and the lumen of the vein was now occupied by massed neutrophile leucocytes, and already the greater part of the wall of the vein was broken down. This rapid and early disintegration of the wall of the vein is therefore suggested as the reason why it was difficult to find definite proof of the portal venous embolism. As already indicated, since no less than four separate venous branches contained the parasite and gave evidence of its

recent arrival, the inference was that the embolic infection of the liver from some enteral source was still an active process up to the time of death. (Compare Figure III.)

Since a tendency to spread is a characteristic feature of all thrombi, once they have started, it is not hard to understand why there should be widespread thrombosis and thrombophlebitis of the portal venous branches within the liver, even at a distance from any recognizable colony of the parasites. This remote or secondary thrombophlebitis was distinguished further by the fact that the neutrophile leucocytic reaction was at a minimum, while an endothelial reaction was at a maximum, and occasionally a plasma cell and a histiocyte reaction was superadded. The effect of this endothelial reaction varied. Sometimes the endothelial and other cells completely blocked the lumen of the vein. At other times the endothelial reaction took the form of a vigorous canalization of the thrombosed vein by a proliferation of endothelial tubes carrying blood. In many such instances the end-result closely resembled that found in *thromboangiitis obliterans* (thrombo-arteritis) of the arteries of the leg.

#### *Infarction of the Liver due to the Portal Venous Thrombosis and Thrombophlebitis.*

Another interesting and unexpected fact was that there were extensive areas of necrosis in which all structures, including liver cells, intercellular tissues, and even portal tracts themselves had become necrotic. At first I thought that this necrosis was due to the local liberation of toxin from the actino-colonies. But then I saw (i) that it was quite usual to find living and well preserved liver cells close up to some actinomycotic colonies, and (ii) that the necrotic areas extended some distance away from any colony and from any massed colonies. Again, in the Fallopian infection described in our previous paper,<sup>(126)</sup> we had found that "the radius of toxic action is very limited", so that some other explanation of this relatively extensive necrosis was indicated. (Compare Figure IV.)

I think that explanation is to be found in the portal thrombosis and thrombophlebitis which also is relatively extensive; so that these necrotic patches of liver tissue, involving also the portal tracts, would be of the nature of infarcts resulting from blocking of the portal veins by the spreading thrombophlebitis induced by the actinomycotic emboli. In these necrotic portal tracts the vein was usually, but not invariably, obliterated by thrombophlebitis after the manner already described; only once were a colony of the actinomyces and its bed of leucocytes seen to be caught in an area of infarction.

#### *The Cell Reactions Around the Colonies of Actinomyces.*

It had already been noted that the arrival of a colony of actinomyces within a portal vein quickly attracted neutrophile leucocytes around it and disintegrated the wall of the vein so that all the older colonies (and they formed the vast majority) were embedded in a dense aggregate of neutrophile leucocytes enclosed by liver tissue. The local toxic effect on the liver was practically a localized cirrhosis in the immediate neighbourhood of the actino-colonies—often extreme but never extensive.

Although strongly attracted by the positive chemotaxis of the mature colonies, the neutrophile leucocytes showed little or no tendency to undergo autolysis; in other words, there was practically no true suppuration, only a dense gathering of these leucocytes. Beyond this neutrophilic bed, and particularly in sections of loculi beyond the place where the parasite was located, plasma cells and histiocytes began to appear and ultimately to outnumber the neutrophile leucocytes, as if these plasma cells and histiocytes were attracted by a less potent stimulus. These cell reactions in the actino-



mycotic liver appeared on the whole to be less elaborate than those which are described in greater detail in our paper on a Fallopian tube infection by actinomyces.

#### COMMENT.

(S. S. Gardiner.)

Time and space forbid me to enter into the question of blood stream infection of the kidney or to consider certain factors which apparently favour localization of infection in the kidney.

It has been definitely established that, when an actinomycotic renal lesion communicates with the pelvis of the kidney, the corresponding renal pelvis and ureter, the urinary vesicle and urethra may remain free from infection, despite the fact that urine containing colonies of the organism of actinomycosis has passed through these structures for weeks and even months.

A study of available literature and of my first case leads me to believe that the kidneys may intermittently excrete the organism of actinomycosis or actinomyces colonies for years and yet remain free, at least clinically and physically, from organic impairment of function.

Instrumental and/or chemical trauma and possibly secondary infection may have induced favourable conditions for the colonization of the organism in the renal pelvis and bladder.

It would be futile also to attempt to review the conflicting theories which have been formulated, or to enumerate the experimental deductions which have been made, or to epitomize the clinical research work which has been performed on intraluminal and intramural ascent of infection to the kidney from the lower urinary and genital tracts, and it would serve no useful purpose even to mention briefly the clinical and experimental research work which has been recorded on the lymphatic vessels of these two last-mentioned areas.

The history and the progress of the infection in the second case lead me to suggest that the renal infection in this instance was due to ascent of infection from an apparently primary focus in the urethra, but one cannot determine whether the renal lesion was due to extension of the infection by continuity or caused by haematogenous or lymphogenous invasion. Instrumentation, chemical irritation, secondary infection or a combination of these agencies may have contributed to the colonization of the organism in the vicinity of the upper renal pelvis.

The third case is interesting on account of the fact that the infection of the right kidney reduced the kidney substance to a relatively small granulomatous mass and was probably due to retroperitoneal extension of infection from an apparently primary focus in the region of the appendix or operative trauma. It is the more interesting because of the presence of actinomyces colonies in the lumen of minute branches of the portal vein, and the presence of one small colony within a tributary of the hepatic vein with no evidence of actual infection of the lungs in two areas which indicated the possibility of haematogenous pulmonary invasion, and also on account of the presence of a reno-cutaneous fistula. It may be mentioned here that Nathan<sup>(130)</sup> has reported a somewhat similar but more advanced case, in which the mesenteric lymph glands were infected and numerous actinomycotic abscesses were found in the lungs. Although "a characteristic mycelial mass was found within the lumen of a small pulmonary vein in the region of a subpleural abscess", no evidence of dissemination of the infection by the systemic circulation was determined at autopsy.



Richter's<sup>(9)</sup> case is also interesting. His patient developed metastatic actinomycotic abscesses in the liver, lungs and kidneys from an apparently primary focus of infection in the region of the appendix.

Microscopic examination of sections of lung tissue in one situation revealed a number of actinomyces in an embolus in a small pulmonary artery and in a capillary vessel. "An individual actinomyces filament was found in a capillary vessel and was seen longitudinally in one section and a second filament was found half within and half outside the capillary vessel."

My own two patients whose case histories are recorded in this article and who are still living will, of course, be kept under observation for some considerable time, owing to the length of the interval which may elapse before the disease reasserts its presence.

#### MEDICO-LEGAL ASPECTS.

Noesske,<sup>(131)</sup> from a study of the literature and his own cases, concluded that a single trauma may play an important role in the development of many actinomycotic lesions, and he believed that actinomycotic lesions induced by trauma should receive the same consideration in industrial compensation practice as suppurative and tuberculous lesions following injury.

It must be remembered that actinomycosis may develop in acute fashion, but usually the lesion is of such a nature "as to be contracted by gradual process" and may not appear primarily clinically (or even sometimes after bacteriological and histological examination) at or near the site at which an injury is received.

Since compensation acts are in force in almost all civilized countries of the world, the fact that an actinomycotic lesion may follow an injury necessitates that we should be familiar with the few cases of actinomycosis in which compensation has been granted.

Küttner<sup>(132)</sup> states that there are three groups of traumatic actinomycotic lesions to be considered: (i) a lesion due to direct implantation of the organism of actinomycosis into the wound, (ii) a lesion due to secondary migration of the organism to the injured area, (iii) a lesion due to latent infection becoming manifest as the result of trauma.

In available literature I am unable to find any record of compensation having been awarded in a case of actinomycosis to illustrate the first type of traumatic lesion which has developed in the region of the bladder, ureter or kidney. It may be mentioned, however, that both Noesske and Küttner mention Rotter's case in which an actinomycotic lesion developed in the thoracic wall and was recognized by the Imperial Insurance Board as being due to the effect at the site of the lesion of a kick by a horse two years previously which had caused a wound in the skin.

Noesske and Küttner also mention a case reported by Okuniewski,<sup>(133)</sup> whose article at the time of writing is not to hand. The patient, a stoker, aged twenty-two years, developed pyæmic actinomycosis and died within six months after receiving a slight injury to the little finger of his left hand and which occurred while engaged filling a sack with straw. The diagnosis of the patient's illness was made about one month after the injury was received.

Küttner regards the two cases of actinomycosis which developed as the late result of war injuries and reported by Boyksen,<sup>(134)</sup> as examples of the second type of actinomycotic lesion produced by trauma. In the first case, actinomycosis developed following a severe abdomino-pelvic gunshot wound, and was recognized during the life of the patient as a case for military compensation by the Government Board for War Compensation. The second patient died as a result of actinomycosis following a fractured pelvis which

was caused by collapse of the wall of a trench. The diagnosis of the illnesses of these patients was made five and twelve years respectively after the war injury was sustained.

Küttner also mentions eight cases of actinomycosis which developed in Swiss soldiers whose illness was regarded by the Swiss Military Insurance Board as cases of "professional illness of soldiers" in which liability to compensation was recognized.

As examples of the third group, Küttner mentions a few cases in which actinomycotic lesions developed in connexion with the operative trauma produced in the removal of a chronically inflamed appendix.

Noesske mentions Brunner's case in which the relatives of the deceased were granted full compensation. The patient, a labourer, aged fifty-seven years, slipped while carrying a beam and fell in such a way that the beam fell upon him, causing an injury to the lower part of the abdominal wall on the right side. The patient died sixteen months after the accident. At autopsy an actinomycotic abscess was found adherent to the caecum, and numerous fistulae were found communicating with the pelvic viscera.

Zondek's<sup>(135)</sup> patient, a boy, aged twelve years, suffered a blow on the abdomen during a fight with another boy, and about ten weeks later developed at the umbilicus a fluctuating mass, the size of a plum. Later, urinary and rectal fistulae developed. The patient died about five months after receiving the injury. Autopsy revealed actinomycosis of the right lower abdominal wall, ilio-caecal region, actinomycotic abscesses in the liver and miliary actinomycosis of the peritoneum, omentum, mesentery and diaphragm.

Hochenegg<sup>(136)</sup> has reported a case which occurred in a blacksmith, aged forty-three years, whose bladder was completely surrounded by indurated actinomycotic tissue. "The capacity of the bladder was not greatly altered and the chemical composition of the urine was normal." A tumour, about the size of a man's head, developed in the hypogastric region and was attributed to a blow in that region by a hammer weighing 10 to 12 kilograms and which was received about a year previously while he was at work. The patient apparently recovered.

Küttner, one of the best known authorities on the medico-legal aspect of traumatic actinomycosis, believes that the period of incubation is of great importance in passing a medico-legal verdict upon traumatic actinomycosis. In cases in which a definite diagnosis of actinomycosis is made within a few days after an injury is received, one is justified in assuming that the injury merely called attention to the disease which existed before the injury was received or "that other motives were perhaps involved".

"While it is advisable", he writes, "to be very conservative in pronouncing a verdict when the period of incubation is short, this caution is much less to be observed when there is a long period elapsing between injury and evident actinomycosis." A number of cases have been mentioned which serve as clear examples of incubation of a number of years' duration. It is only a question whether the connexion with trauma can still be recognized if the period elapsing is unusually long, as in the cases reported by Bollinger and Tusini, in which the author says he would, if called upon to pass a verdict, recognize the connexion between the manifestation of the lesions and the injuries which occurred respectively thirty-seven and seventeen years previously. In cases in which any part of the urinary system is the site of an actinomycotic lesion and the patient alleges that his illness and incapacity for work are due to injury received at his employment and appendicectomy or almost any other abdominal operation has been performed previous or subsequent to his injury, it may be difficult to establish a connexion which

would point to the external traumatic origin of the infection and prove to the court beyond any doubt that the patient had been infected at a particular time and date and place and that his incapacity "arose out of and in the course of his employment". Furthermore, in cases in which any part of the urinary system is the site of an actinomycotic lesion and in which the disease is alleged to be due to external trauma, or to the inhalation or ingestion of the organism in the course of employment, it must be remembered that under the law as at present constituted in the State of New South Wales an employee who has been injured in the course of his employment is required to give his employer notice "as soon as practicable after the happening thereof and before the worker has voluntarily left the employment in which he was at the time of his injury". Absence of notice or delay in notice is always regarded by the court as a factor in determining the genuineness of the applicant's claim. In the case of a patient suffering from actinomycosis of any part of the urinary organs, it may be impossible to comply with this section, as the applicant may be suffering from the disease for some time before diagnosis is definitely established; in fact, the correct diagnosis of the patient's illness is sometimes established only after a complete autopsy examination has been made and subsequent careful microscopic examination of sections of organs, tissues or pus obtained at autopsy.

The above-mentioned facts must be ever remembered, especially in cases in which no previous abdominal operation has been performed and in which the disease is associated with external trauma claimed to be the occasion of the genesis of the disease "incidental to or originated in the performance of duties or work or the occupation of a workman".

It is suggested that any amending legislation in respect of this disease should make some provision suitable to all the circumstances and thus lessen the number of claimants who, having failed to establish their claim for compensation, in consequence become a burden on the State.

#### SUMMARY.

Three cases of actinomycosis involving the urinary system are reported and available literature up to the end of 1936 has been reviewed.

Actinomycosis is not always a suppurative process.

The possibility of urethritis being caused by the organism of actinomycosis cannot be disregarded.

The clinical picture of actinomycotic lesions in the kidney and bladder and also autopsy revelations are not characteristic.

More cases will be diagnosed correctly if the surgeon or clinician is "actinomycosis-minded".

The paucity of cases reported is doubtless due to the fact that routine microscopic examination of specimens of urine of patients suffering from actinomycosis in other regions of the body has been omitted and also to the fact that routine microscopic examination of specimens removed at operation or obtained at autopsy has been neglected.

The medico-legal aspect of the disease is mentioned.

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## Case Reports.

### ARTERIO-VEINUS (CAROTID-JUGULAR) FISTULA AND CAROTID ANEURYSM.<sup>1</sup>

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NUMEROUS examples of arterio-venous fistula have been described, but the variety of clinical phenomena dependent on differences in size and site of the lesion (as well as other factors) justifies the recording of additional cases. The following case is therefore recounted here.

The patient, D.B., aged twenty-three years, was wounded in action in the left side of the neck. The missile entered at the base of the neck on the left side just above the anterior extremity of the clavicle. It traversed the neck and escaped (having apparently become separated into two fragments) at two points posteriorly. One was above the middle of the superior border of the left scapula; the other was slightly above this level and about one and a half inches from the mid-line.

He was taken prisoner and his wounds were dressed in an enemy hospital. He was recovered, however, and arrived at one of our own units, a casualty clearing station, on the fourth day.

All the wounds were infected, and there was a diffuse swelling at the base of the neck and there was a definite systolic thrill. He had been wounded in the middle and ring fingers of the right hand; the middle finger was amputated.

Ten days later he was admitted to a general hospital. The wounds of the neck were infected and discharging pus. There was a considerable diffuse pulsatile swelling in the region of the lower part of the left sternocleidomastoid muscle. A gross systolic thrill could be palpated and auscultated over this region. There was a paresis of the left deltoid, biceps and brachioradialis muscles, and there was an area of anæsthesia over the outer part of the arm and forearm. His voice was hoarse, and paralysis of the left vocal cord was observed.

During the next month the wounds gradually healed. The swelling at the left side of the base of the neck became less diffuse and smaller. A definite thrill was still present over this area. There was also now a pulsatile swelling in the lateral triangle of the neck extending about half an inch lateral to the sternocleidomastoid

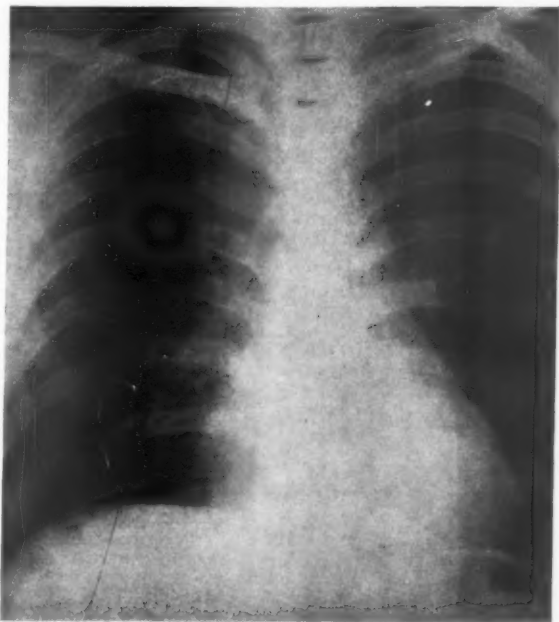


FIGURE 1. Skiagram of the chest before operation showing general enlargement of the heart.

<sup>1</sup> Accepted for publication on December 11, 1942.

muscle. Both the thrill and pulsation could be eliminated by pressure of one finger tip at a point over the anterior border of the sternocleidomastoid muscle about one inch above the clavicle.

The muscular weakness of the arm and forearm and alterations in sensation were still present and corresponded in distribution with the supply of the fifth and sixth cervical nerves.

The apex beat was just within the nipple line in the fifth intercostal space. The systolic blood pressure was 126 millimetres of mercury and the diastolic pressure 55 millimetres in the left arm; the systolic pressure was 128 millimetres and the diastolic pressure 68 millimetres in the right arm. X-ray examination revealed a general enlargement of the heart (Figure I).

The mental condition of the patient was normal, except that cerebration was distinctly slow. Interrogation of the men in his unit revealed that this was no different from "what it had always been".

Eight weeks after infliction of the wound, operation was undertaken. Under ether anaesthesia given by the open method an angled incision was made at the base of the neck on the left side. One limb of this extended for two and a half inches along the lower part of the anterior border of the sternocleidomastoid muscle and tendon, and the other for two inches along the upper border of the clavicle. The flap of skin,

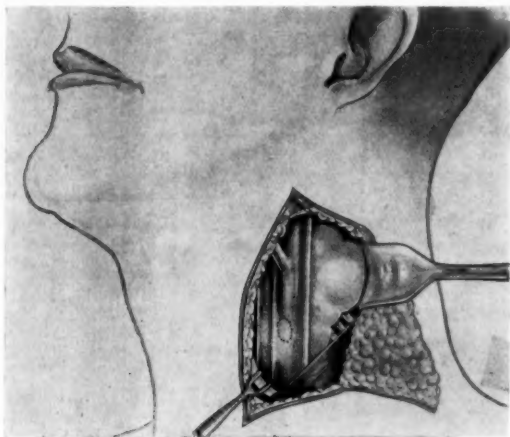


FIGURE II. Drawing to show conditions found at operation. The skin flap has been turned back and the sternocleidomastoid muscle retracted well laterally to demonstrate the vessels. The site of the fistula between the internal jugular vein and the internal carotid artery is indicated. The irregular aneurysm arising from the posterior aspect of the carotid artery is to be seen.

platysma and fascia were turned laterally, the fascia was incised along the anterior border of the sternocleidomastoid muscle and the muscle was retracted laterally. The omohyoid muscle was retracted caudally and the vascular sheath opened. The vessels were demonstrated and a sacular aneurysm was found posterior and lateral to the vessels (Figure II). Compression of the carotid artery lessened the pulsation in the aneurysm, but did not stop this completely.

The exact site of the arterio-venous fistula could now be determined and the thrill controlled by local pressure at one point. The jugular vein was dissected free above and below this point, and it was then doubly ligated at both places. The vein was divided between each of the two pairs of ligatures. Crille's clamps were placed on the carotid artery above and below the fistula and the vein was dissected away from it. When the vein was removed the oval

fistula was demonstrated and in the posterior wall of the artery, through the opening, could be seen another opening which communicated with the aneurysm. Arteriorrhaphy had been contemplated, but was considered unwise in view of the two openings. The artery was ligated on either side of the openings.

The aneurysm was now partially obliterated by sutures and the wound was closed, a small drainage tube being placed down to the deeper layers.

Convalescence was uneventful, there being no apparent change in the soldier's mental state. The wound healed rapidly and well.

Six days after operation the blood pressure in the left arm was 116 and 64 millimetres of mercury, systolic and diastolic respectively; in the right arm the figures were 120 and 74 millimetres. The apex beat was now in the fourth intercostal space and about one inch internal to the nipple line. X-ray examination of the chest showed the heart to be now three-quarters of an inch smaller in transverse diameter than it was before operation (Figure III).

Three weeks after operation the wound was soundly healed and there was no abnormal pulsation in the side or base of the neck and no thrill could be felt. Power had returned to the left arm, there being only a slight residual paresis of the deltoid muscle. The patient's voice was stronger and less hoarse.

Four months after operation he was seen again. All his muscles (in the left arm) had recovered completely. The only disturbance of sensation was slight paræsthesia over an area on the outer aspect of the elbow. His voice had recovered. His general condition was very good and the figures for systolic and diastolic blood pressure were 118 and 68 millimetres of mercury in the left arm and 120 and 78 millimetres in the right arm. The wound was healed and there was no abnormal swelling or thickening in the neck.

#### Discussion.

This case shows a number of the typical features of arterio-venous fistula of large vessels which are, however, complicated by the presence of a saccular aneurysm.

The changes in blood pressure after operation—the fall in systolic pressure and, more important, the rise in diastolic pressure—were demonstrated in both arms. This change was more apparent on the left side, as might be expected from the position of the lesion.

The reduction in the size of the heart was dramatic. Alteration in the site of the apex beat was observed on the second day, but X-ray confirmation was not obtained till the sixth day after operation, as it was necessary to have as nearly as possible the same conditions (posture of patient *et cetera*) as before operation. The diminution in heart size was much greater than was observed in other cases of smaller fistula or in those in other vessels. This exemplifies the statement that the greatest and most rapid change occurs in the case of fistula of large vessels and in those nearest to the heart. It is clear that in this case considerable dilatation of the heart developed within eight weeks of the injury and recovered, once the vascular defect had been dealt with, within a few days, if not hours.

No discussion of the mechanism of the cardiac dilatation is necessary, but the two main hypotheses of its mode of development are of interest. One, sponsored by many observers, is that the return of a large amount of blood to the heart by way of the fistula—constituting a short-circuit of a considerable quantity—throws a considerable strain on the organ. When one considers the remarkable capacity of the heart to respond to greatly increased and often sudden demands, this is not a particularly satisfying explanation. The other, having amongst its protagonists that shrewd observer Sir Thomas Lewis, is that the reduction in diastolic pressure results in a diminution in the pressure in the coronary vessels, and thus in a diminished vascular supply to the cardiac muscle. This causes some degree of cardiac insufficiency and hence dilatation of the heart. There are, however, other features, such as the alterations in the vessels, particularly the artery proximal to the fistula, that make it clear that this is not the sole explanation.

Alterations which occur in that part of the vascular tree peripheral to the fistula (including the development of an adequate collateral circulation) are such that surgical interference with a large vessel, which in ordinary circumstances might lead to serious complications, can be undertaken with impunity. In this case ligation of the common carotid artery was not followed by any suggestion of disturbance of the



FIGURE III. Skiagram of chest six days after operation showing reduction in size of the heart as compared with previous film (Figure I). Both films were taken, as far as possible, under identical conditions.

cerebrum. Of course, such disturbance, if it were to have occurred, might have been expected at the time of the original injury.

The aneurysm caused some difficulty in the original diagnosis. The diagnosis of a double lesion was not made with certainty, and even at operation it was thought that this arose from some artery other than the carotid. It was found that, as often happens in traumatic aneurysms, it had in addition to its main opening from the carotid artery, other small openings from which blood flowed into it; and this accounted for some pulsation continuing even after the main artery had been controlled.

The various nerve lesions may have been due in part to the original injury, but their rapid recovery suggested that they were at least partly caused by pressure of the aneurysm.

#### Summary.

A case of traumatic arterio-venous fistula involving the left carotid artery and internal jugular vein, with an associated saccular aneurysm, is described. The vascular complications and their response to operation are recorded.

#### Acknowledgements.

I am indebted for the drawing (Figure II) to Major B. K. Rank, in whose unit this was prepared, and to Major K. Myers for the reproduction of the X-ray photographs.

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## Surgery in Other Countries.

[In this column will be published short résumés of articles likely to be of practical value from Journals published in other countries and not readily accessible to surgeons in Australia and New Zealand.]

### PRIMARY CHOLANGIOGRAPHY.

**Nils Liedberg (Lund):** "*Erfahrungen mit primärer Cholangiographie, unter besonderer Berücksichtigung etwaiger Schädigungen des Pankreas*", *Acta chirurgica Scandinavica*, Volume lxxxv, 1941, page 261.

TRUE "primary cholangiography", which would be a preliminary pre-operative diagnostic procedure, has been attempted by means of duodenal intubation, the duodenum being blocked above and below the papilla by means of balloons and the intervening portion being filled with contrast medium and reflux occurring into the bile passages. At the present this method has nothing more than a theoretical value as a possibility; and Liedberg uses the term primary cholangiography to indicate deliberate radiological examination of the bile passages as an integral part of an operation on the gall-bladder or ducts. He distinguishes this procedure from that in which contrast fluid is later injected into the ducts through a fistula or an indwelling drainage tube, and which he calls secondary cholangiography.

By the technique employed very little extra time is consumed, the film being taken immediately the cystic duct is isolated, and the development of it being carried out while the gall-bladder is being removed. The contrast fluid used is "Per-Abrodil"; but since the "contrast shadows" of small stones may be obscured by its density, it is diluted with half its volume of normal saline solution. A wooden cassette tunnel is placed under the patient, from either side of which the cassette can be removed. The portable X-ray unit used must be capable of giving a good result with one second's exposure. The need for eliminating respiratory movement during exposure is met by the use of spinal anaesthesia in all suitable cases. When this cannot be done, nitrous oxide and ether are given, and a large dose of oxygen is given immediately before the exposure is made to produce apnoea. A small lateral opening is made in the cystic duct as soon as it has been isolated, and into this opening a blunt cannula is introduced and fixed in position by a ligature or light rubber-covered clamps. Ten cubic centimetres of contrast fluid are injected and an immediate exposure is made. This is generally followed at Lund by a second injection and a further exposure. The cannula is left in position during the development of the film in case a check exposure is needed later in the operation.

The interpretation of the films secured is a matter of considerable difficulty at times, owing to the number of factors exercising unknown effects; but their greatest value lies in the demonstration of the presence or absence of stones in the common duct. Stones should show as definitely shaped filling defects in the duct shadows. This may seem superfluous in those cases in which the clinical picture is such as to leave little doubt of the presence of stones. But even in these the knowledge gained of the number and position is of very great importance. Liedberg quotes a case in which after the removal of thirteen stones of various sizes the ducts appeared to be quite clear; but a check cholangiography showed that five more were still present in the right and left hepatic ducts; they were then successfully removed. In another case which he quotes the first film taken showed a stone close to the papillary opening of the duct which was thickened and dilated. It could not be felt with the palpating finger nor found on exploration of the duct. A check cholangiogram showed that it was no longer present and the abdomen was closed. Five days later a stone, corresponding in shape and size to that seen in the first film, was passed by the patient, having evidently been assisted through the papilla by the palpating finger.

Some authors go so far as to state that a "negative" cholangiogram relieves the surgeon from the need to make any further exploration of the ducts, but Liedberg does not subscribe to this view. He holds that when clinical or operative findings indicate an exploration of the common duct, this should be done quite regardless of the negative result of the cholangiogram. He quotes a case in support of his opinion. In this instance on a second study of a dry film the presence of a small stone which been found in the duct, though missed in the first study of the film, was recognized.

Obstruction to the passage of contrast fluid into the duodenum must, in the absence of stone shadows, be interpreted with great care. Often a second film will show the obstruction, evidently due to spasm or swelling, to have been spontaneously overcome.

The paper concludes with some interesting observations on the occurrence and significance of a reflux of contrast fluid into the pancreatic ducts. This occurred in 50% of Liedberg's cases. It is a higher percentage than is shown by most authors, and he attributes this to the fact that he uses spinal anaesthesia as a routine procedure. In an endeavour to determine whether the reflux had any serious effects, it was made a routine procedure to estimate the urinary diastase before and after cholangiography. In eight out of fifty cases so investigated there was found to be an increase in the urinary diastase beyond what is taken to be of pathological significance—namely, 512 Wohlgemuth units. In these eight cases the urinary diastase ranged from 512 to 16,384 Wohlgemuth units, but in no case did any clinical sign of pancreatitis manifest itself. Several authors have pointed out that the operative trauma of a simple choledochotomy, with palpation of the pancreas, is sufficient to give rise in many cases to a high urinary diastase content; and in several series of cases of uncomplicated acute cholecystitis a similar increase in the urinary diastase has been found in nearly 50% of the cases. The eight patients under review here all had normal diastase values before operation. None suffered from acute bile duct infection. In two of them the common duct was not opened; in the other six it was explored, stones being found in four, no stones in the other two. It is thus very possible that it is operative trauma rather than the cholangiography which produced the diastasuria, especially as contrast fluid was seen in the pancreatic ducts in only five of the eight; while in fifteen other cases in which contrast fluid was shown to have flowed along the duct there was no rise in the urinary diastase reading. None the less Liedberg believes that the possibility of pancreatic damage resulting from the reflux of mixed bile and contrast fluid into the pancreatic ducts cannot be dismissed or ignored entirely, even if no harm has so far been shown to result from it; and he advises that the procedure should not be carried out in the presence of acute infection of the bile passages.

ARTHUR E. BROWN.

#### COMBINED "EVIPAN" AND NITROUS OXIDE AND OXYGEN ANÆSTHESIA.

**Tore P. Störtebecker** (Oslo): *Acta chirurgica Scandinavica*, Volume lxxxv, 1941.

In the clinic of Westerborn at Gothenburg in Sweden there has been a large swing away from ether anaesthesia in any form and towards a combination of "Evipan" with nitrous oxide and oxygen.

The patient receives a preliminary injection of 1.5 centigrammes of morphine or "Pantopon" about an hour before the operation. "Evipan" in freshly made 10% solution is injected into the cubital vein at a rate of one cubic centimetre in thirty seconds, the patient being asked to count slowly and otherwise being sedulously guarded from any outside stimuli of noise, conversation or other sort. On the patient falling asleep and ceasing to count, there is a pause of a minute or so, and then a further one cubic centimetre is injected even more slowly than before. The syringe is then retained with its needle in the vein in case of the need of further dosage. It is therefore one person's exclusive responsibility to be in charge of the "Evipan" injection. To prevent clotting in the needle the syringe and needle are often previously moistened with "Heparin".

At this stage administration of gas and oxygen is started, and it is found that this anaesthesia always goes more smoothly from induction to awakening than it does in the absence of the preliminary injection of "Evipan". To achieve full relaxation the gas is given for five or ten minutes before surgical measures are started. Should the result be unsatisfactory, a further injection of 0.5 centimetre of "Evipan" is given, and this dose can be given at critical periods of the operation when a deeper anaesthesia is required.

The following figures, being an average for a hundred consecutive cases, are given for the procedure:

Duration of surgical procedure: 55 minutes.  
 Induction of anaesthesia: 2½ minutes.  
 Total anaesthesia: 60 minutes.  
 Total sleep: 62 minutes.  
 "Sleeping dose" of "Evipan": 3.4 cubic centimetres.  
 Dose to start of surgery: 4.7 cubic centimetres.  
 Total "Evipan" used: 8.3 cubic centimetres.  
 Gas consumption (nitrous oxide): 6 litres per minute.  
 Oxygen percentage: 15.

The blood pressure has not in any case shown any significant fall. The use of "Evipan" in addition to nitrous oxide and oxygen has a number of advantages. It eliminates the patient's fear and also his memory of the face mask and the unpleasant sensations of "going under". It shortens the actual induction period and reduces the amount of gas used. The often reported shallow respirations of patients anaesthetized

with "Evipan" are effectively countered by proper use of the gas and by the use of a rebreathing bag. The patient is said to be fully awake in three minutes after the operation and to suffer less from nausea and vomiting than after other methods.

Neither cardiac disability nor pulmonary diseases, acute or chronic, provide a contraindication to this method of anaesthesia. Patients with severe liver damage must be approached with caution, owing to the lesser dosage required in the absence of efficient liver elimination of the "Evipan"; but with that proviso it can be safely administered. And there is no sulphur element in "Evipan", as there is in "Pentothal", that would make its use in conjunction with sulphanilamide at all hazardous.

ARTHUR E. BROWN.

#### A SIMPLIFIED METHOD FOR OBTAINING ROOT ANÆSTHESIA OF THE SECOND AND THIRD BRANCHES OF THE FIFTH NERVE BY THE EXTRAORAL ROUTE.

Quittner (Kaunas): "*Eine vereinfachte Methode der extraoralen Stammanästhesie des II und III Trigeminusastes und des Ganglion Gaseri*", *Acta chirurgica Scandinavica*, Volume ix, 1941, page 458.

QUITTNER claims that the need for root anaesthesia is of increasing importance owing to the growing frequency of mechanical and military injuries to the jaws and face. The main difficulty about it lies primarily in the anatomical relations of the ganglion and its branches. The orbital approach to the maxillary division is often successful, but is obviously dangerous. The other commonly used approaches are difficult and have their own dangers and disadvantages. Quittner in this paper proposes a method which he states is simpler, more certain and less dangerous than others.

The following bony points are important in this procedure: 1, the zygomatic arch; 2, the lateral plate of the pterygoid process; 3, the pterygo-palatine fossa; 4, the *foramen ovale*; 5, the infratemporal plane; 6, the oblique line rising to the coronoid process of the mandible, indicating the inner surface of the ramus, and the vertical ramus rising to the articular process. The technique for injection of the two main divisions is as follows.

The width of the vertical ramus of the mandible is marked on the cheek by two short lines indicating its anterior and posterior borders and placed at about the level of the line joining the tragus to the *ala nasi*. The distance between these two lines is measured, and one-third of this distance back from the anterior of the two marks is taken as the position for a vertical line. The point where this last line crosses the lower border of the zygoma is the point of entry for the needle. The needle used is of a diameter of about 0.8 to 1.0 millimetre, and it should be 6.5 to 7.0 centimetres in length. It is pushed through a cork, which should mark off the depth of 5.5 centimetres. The needle is pushed directly inwards, and at a depth of 4.0 to 5.0 centimetres it encounters bony resistance, which cannot be anything other than the lateral pterygoid plate. At this stage a few drops of the anæsthetic fluid are injected to render the remaining steps painless. If the needle point is now moved forward along the surface of the bone, the point at which it is felt to lose contact with bone and to tend to slip in a little deeper is the pterygo-palatine fossa, wherein the second division of the trigeminal nerve lies. If, on the other hand, the needle is moved backward till it loses bony contact, the point at which it slips more deeply is the *foramen ovale*, with the third division. For greater certainty, these manœuvres can be repeated. The depth of the needle is usually some 5.5 centimetres—the depth marked by the cork. Two or three cubic centimetres of a 2% or 4% anæsthetic solution are now injected, and in about twenty minutes anaesthesia is complete. The descending palatine and pterygo-palatine arteries lie in the pterygo-palatine fossa in the neighbourhood of the second division of the nerve. When the third division is injected at a depth of 5.5 centimetres the vessels and Eustachian tube are out of danger. All the usual precautions needed in injecting fluid into deep planes should of course be taken.

The technique for finding the *foramen ovale* and entering it for the injection of the Gasserian ganglion is the following. A needle is put into the cheek as if for the injection of the third division and is left in place, its point lying in the neighbourhood of the *foramen ovale*. In it is a steel stylette, which projects just beyond the point. After the skin has been anaesthetized, a 10 centimetres long needle is now inserted about three centimetres lateral to the angle of the mouth, behind the zygomatico-alveolar crest, at the level of the second molar tooth. This is aimed at the infratemporal plane at its median boundary, where the pterygoid process takes its origin. The point of this needle now finds the needle already left in place, and must pass above it, moving backward and slightly inwards to find the *foramen ovale*. Holding the two needles, the operator explores with the lower one towards the angle between the infratemporal plane and the posterior border of the pterygoid process. The long needle will be felt suddenly to lose its bony contact and glide into a deeper plane. Cork control will

prevent it from passing into the foramen to a depth greater than 1.5 to 2.0 centimetres, and the injection can then be carried out. The foramen is usually about 5.0 to 7.0 centimetres from the point of entry of the needle, and the maximum depth for the needle to penetrate should be 8.5 centimetres. This distance should be marked by a cork stopper. When the stylette is withdrawn slight suction is made, and if fluid escapes the point is withdrawn and suction is tried afresh at a slightly less deep level. The patient should remain still for some twenty minutes after the injection. By this two-needle method the foramen is most easily found, and by keeping above the guide needle the risk of aiming low into dangerous areas is almost entirely avoided.

ARTHUR E. BROWN.

#### THE APPROACH TO THE SCIATIC NERVE IN ITS UPPER THIRD.

G. af Björkesten (Finnish Red Cross Hospital): "*Über die Freilegung des Nervus ischiadicus in seinem oberen Drittel*", *Acta chirurgica Scandinavica*, Volume lxxxv, 1941, page 41.

THE key to the uncovering of the upper part of the sciatic nerve is the *gluteus maximus* muscle. Most attempts to expose the nerve in this situation have involved incisions through this muscle in various directions; but in addition to difficulties arising from inadequate exposure by this route there is always a very free and troublesome bleeding; so much so that von Foerster and Pausepp, who recommend this approach, also advise the suture of the edges of the muscle wound with catgut in the endeavour to control the bleeding.

Björkesten draws renewed attention to the procedure of Iselin, who uses a complete, and of Stookey, who is satisfied with a partial, separation of the great gluteal muscle from its insertion to the femur and fascia. And he presents a series of fifteen cases of high sciatic injury in which operation by this route was undertaken.

The incision used is that of Iselin and Stookey. It starts from the posterior superior iliac spine, and curves outward and downward, passing medially and caudally to the great trochanter. Thence it curves inward, passing over the gluteal fold to reach the mid-line of the thigh, from which point it may at will be carried down the thigh as far as may be necessary. As the lower margin of the *gluteus maximus* does not correspond accurately with the gluteal fold, the incision should come well below the fold. After the necessary freeing of the skin in a lateral direction, the upper and lower borders of the muscle mass are defined, and over a director the muscle is cut through as close to the actual insertion as possible. In the lower part it is often difficult to get out far enough to avoid cutting through muscle fibre instead of tendon; and in this case there is always free bleeding. The muscle flap is then dissected free and turned over medially. In old-standing cases with much scar formation it is often very difficult to strike the right plane; but this is the easier, the closer the surgeon keeps to the insertion. In a few cases the upper part of the insertion was not divided, the upper border of the muscle flap being separated by blunt dissection in the direction of the fibres after the method of Stookey. Equally good exposure was thus obtained, but the bleeding met with was much more profuse.

The exposure attained was surprisingly good, the sciatic being seen lying bare to the border of the pyriformis muscle. In one case in this series repair of the nerve had to be undertaken actually in the pyriformis foramen, and Björkesten affirms that by no other method could such good access be obtained. Also it offers the least interference with the normal blood and nerve supply to the muscle. After operation on the nerve, which was possible in all but three of this series (the difficulties in those three having no relation to the nature of the exposure), the muscle was sutured back to its insertion with silk sutures, and in no case was any loss of power or of skin sensation over the buttock noticed after healing.

ARTHUR E. BROWN.

#### SOME POINTS IN THE OPERATIVE MANAGEMENT OF NON-UNITED FRACTURES.

Gustav Levander: "*Einige Gesichtspunkte zur operativen Pseudoarthrosebehandlung*", *Acta chirurgica Scandinavica*, Volume lxxxv, 1941, page 148.

SINCE the primary cause of non-union in fractures is to be found in the fracture site itself rather than in the general condition of the patient, evidence of which is given by the fact that the great majority of such cases occur in powerful healthy men, rational therapy ought to be directed to the actual site of the fracture. Levander believes that new bone formation arises by differentiation from a primitive mesenchymal tissue. He has shown experimentally that an alcohol-soluble substance can be extracted from bone tissues which is capable of stimulating this mesenchymal tissue to the

formation of bone and cartilage. He claims that it is this substance which is responsible for the success attained by Beck's boring and Kirschner's bone splintering procedures, and that a similar action is the main factor in producing regeneration after the use of a "bridge graft" of bone. In fact, it is questionable whether the actual fixation by the graft plays any important part at all, for all relatively old fractures are held together by strong connective tissue bands, and providing sufficient of this tissue is left in place to hold the ends of the fragments together, regeneration will take place as a result of the manipulations alone.

Acting on this principle, Levander has treated a series of such cases coming under his care by merely packing round the bone ends loose shavings of bone removed from the adjacent bone surface. The fracture is laid bare, and all connective tissue is cleared away from between the two fragments. Posteriorly a sufficient band of tissue is left intact to hold the fragments approximately in position. Unless the ends are in actual apposition they are freshened, and bone chips two centimetres long, one centimetre wide and two millimetres thick are flaked by chisel from the neighbouring bone surface. Sometimes the bones are drilled and the bone débris removed by the drill is mixed with a little blood to form a paste, which with the chips is packed loosely round the fracture. The wound is closed and the limb enclosed in plaster.

The advantages claimed for this method over that of bone grafting are several. First, the time needed for producing firm union is much less. Secondly, the operation being much less severe, it can be undertaken much earlier than the major procedure of a bone graft. Thirdly, the danger from infection being less, it is not necessary to wait so long after the healing of a compound fracture before taking definite steps to achieve union. All of these factors lead to a shortening of the period of invalidity; and there is the additional advantage that the operation itself is much less radical and produces equally good results with far less dangers.

Levander is insistent that much of the period of invalidity now suffered by these patients can be saved by the use of this procedure and by its earlier use. The average time taken for healing after a bone graft operation in his service was 8·7 months, while with his recent technique the patients achieved full weight-bearing in 3·1 months after the operation. His patients were under treatment prior to operation for an average period of four months, which he considers is much too long. If a simple fracture has not shown a definite degree of union in two months, the question of operation should be considered; and there are very few cases in which it need be delayed beyond three months. That would make the total period of invalidity only 6·1 months, as against an average time of 19·9 months in a series of cases treated by massive bone grafts.

ARTHUR E. BROWN.

#### A NEW OBSERVATION ON THE RADIOGRAPHIC DIAGNOSIS OF THE DAMAGED KNEE CARTILAGES.

Erik Millbourn (Uddevalla): "*Ein weiteres Arthrogrammsymptom bei Meniskusschäden*", *Acta Chirurgica Scandinavica*, Volume lxxxiii, 1939-1940, page 91.

In 1934 Lagergren published data which established the diagnostic value of radiographic examination of the knee joint after filling it with a radio-opaque contrast material in cases in which damage to one or other of the menisci was suspected, and this method has been largely used in the Uddevalla Clinic ever since. The fluid used was at first "Abrodil", but later a cheaper and equally effective fluid known as "Intron" has been chosen. The fluid is diluted with an equal quantity of normal saline solution, and no untoward after-effects have been observed in any case. The procedure is painless, except that if the joint is too suddenly and thoroughly distended the patient may complain of a severe pain in it; but this is of brief duration, and need not with the employment of a careful technique occur. Results are better if the exudate present in these joints is aspirated before the contrast fluid is injected. Normally the menisci are indicated by a filling defect in the joint space, whose shape and position correspond to those of the normal meniscus. Damage to the cartilage is indicated, according to Lagergren, by the following variations from normal: (i) The outline of the meniscus is diffuse, irregular or deformed. (ii) Some of the contrast fluid can be seen between the meniscus-edge and the capsule to which it should normally be adherent. (iii) Flecks of contrast fluid can be seen in what should be the clear area occupied by the meniscus. (iv) In some planes a full contrast shadow can be seen where there should be cartilage. (v) A defect may be seen in the contrast filling of the joint space, centralwards from the meniscus, dividing the joint space into two, either vertically or horizontally.

Occasionally it is found that none of these criteria are fulfilled, yet on exploration a concentric tear of the meniscus is found. In one such case Millbourn reexamined the film and was able to establish in it a departure from the normal which corresponded to the condition found at the operation, and this sign has been present in nine further cases. It consists in a shortening in the long horizontal length, often combined with



an equally definite shortening in the vertical depth of the clear triangular space at the periphery of the joint, which is unfilled with contrast material, and which represents the meniscus in the arthrogram. In four of the nine cases reported this was the only variation from the normal picture, the arthrogram showing on the injured side a meniscus shadow normal in type, but definitely smaller in dimensions than that on the uninjured side. The operative finding in all these cases was a concentric tear in the cartilage with displacement centrally of the detached fragment. In five other cases the above radiographic sign was present, but in addition to it there were detectable one or more of the other signs laid down by Lagergren as criteria of meniscus damage. The difference in size of the menisci as indicated in the radiographs was unmistakable in all the nine cases. In seven of them the injured one was about half the size of that on the uninjured side; in the other two cases it was about one-third. No mass statistics about the normal dimensions of these meniscus "shadows" apparently exist. Material variations in the actual size and shape of the cartilages are fairly wide, the meniscus at times extending even to a complete disk. But in the presence of symptoms giving rise to the clinical suspicion of meniscus injury the finding of the "shadow" of the suspected meniscus on an X-ray film to be about half that of the other one in the joint, can, even in the absence of any other radiographic signs, offer powerful support to the clinical diagnosis of a concentric tear of the cartilage.

ARTHUR E. BROWN.

## Reviews.

**Massage and Remedial Exercises in Medical and Surgical Conditions.** By N. M. Tidy; Fifth Edition; 1941. Bristol: John Wright and Sons Limited. Demy 8vo, pp. 475, with 182 illustrations. Price: 17s. 6d. net.

THE popularity of this work is evinced by the publication of a fifth edition within the space of nine years, the second since the onset of the world war. While the distinctive characteristics of the previous editions have been retained, a short section on the treatment of the results of burns and wounds has been added. Treatment of amputation stumps, especially in regard to their preparation for the fitting of artificial limbs, is also new.

Many and various are the diseases dealt with, including all the well recognized conditions for which massage and remedial exercises are accepted treatment. A great number of other diseases are, however, described, sometimes *in extenso*, in which the application of massage and remedial exercises appears to be remote.

Excluding the portions devoted to massage and exercises, each subject is discussed from the point of view of aetiology, physiology, pathology, symptoms and complications in such detail as would compare favourably with many textbooks for medical students.

The subject of suspension and pulley exercises is valuable in that it demonstrates the easiest method of performing active exercises when the fatigue factor predominates. The floating movements are not unlike those given in water and are in fact termed dry water treatments.

Scoliosis is well described and illustrated, but some ambiguity exists in regard to the meaning of "antero-posterior in direction" when this term is applied to the position of the spinal pedicles, laminae and transverse processes.

This excellent textbook maintains its high reputation already so well established in this country.

**Blood Substitutes and Blood Transfusion.** Edited by STUART MUDD, M.A., M.D., and WILLIAM THALHIMER, M.D.; 1942. Springfield, Illinois: Charles C. Thomas. London: Baillière, Tindall and Cox. 9½" x 6", pp. 421, with illustrations. Price: \$5.00.

"BLOOD SUBSTITUTES AND BLOOD TRANSFUSION", edited by Stuart Mudd and William Thalhimier, is a work which contains the papers and discussions of seventy collaborating investigators who contributed to a symposium on blood substitutes and blood transfusion. The list of contributors includes the names of many whose original observations have added much to our knowledge of this subject, names such as Aldrich, Best, Blalock, Moon, Whipple and Solandt.

Since blood and blood substitutes are mainly used in the treatment of shock, very naturally the early part of the work is devoted to a rather full presentation of the modern conceptions of the aetiology and mechanisms of secondary shock. Then follows a section in which methods of preservation of plasma and serum by desiccation and freezing are described. Methods, simple and complicated, which should be of great value to laboratory workers, are set out in some detail, and the clinical effectiveness of serum and plasma preserved by the various methods is discussed. Other chapters



deal with the methods and the value of the use of hæmoglobin, serum, albumin and casein digest as substitutes for blood. It is of interest to note that according to the several contributions casein digests given intravenously are effective in promoting an abundant new plasma-protein production.

The storage, transportation and administration of whole blood receives considerable attention and is a valuable contribution. There is too an excellent discussion on the antigenicity of the Rh blood factor. The particular interest that attaches to this factor when the necessity arises to give a transfusion to a mother during pregnancy is touched on, and it is shown that isoimmunization occurs more frequently from the fetus than from repeated transfusions. Isoimmunization by the fetus is postulated as an explanation of repeated spontaneous abortions and miscarriages, and is shown to be a factor in the production of *erythroblastosis fetalis* (*icterus gravis*, anæmia of the newborn *et cetera*).

This book is an epitome of the knowledge of a continent concerning a most important subject, and should be most valuable as a work of reference.

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**A Short History of Cardiology.** By JAMES B. HERRICK, M.D.; 1942. Springfield, Illinois: Charles C. Thomas. London: Baillière, Tindall and Cox. 8½" × 5½", pp. 268, with 48 plates. Price: \$3.50.

No student of cardiology, or indeed of medicine, will fail to be attracted by any work bearing the name of James B. Herrick. His outstanding contributions to the study of coronary occlusion, made some two to three decades ago, though only one of his gifts to medicine, represent one of the great advances of our time. It is noteworthy that in this volume he modestly dismisses them with the statement: "These developments are so recent that they cannot be considered as having become a part of History."

The book is an eminently readable one. It is sufficiently concise and brief, but at the same time contains a wealth of information—somewhat astonishing in the space allowed. This is due in no small measure to Dr. Herrick's ability to sift the chaff and present essential features. Some may consider that in parts it is rather too condensed, but this means merely that interest has been whetted. There is much in the way of elaboration, as witness the discussion of the pros and cons concerning the original nature of Harvey's work on the heart and circulation.

As stated in the preface, the history of disease could be considered in one of several ways: chronologically by epochs, geographically or by pathological divisions. In this book there has been a judicious intermingling of all three. Four great epochs are considered, each in a separate chapter; inflammatory conditions, myocardial affections, syphilis and coronary disease have each a chapter, and a further one is devoted to prognosis.

In each part a more or less definite geographical or national subdivision of the material adds a piquant flavour. This may be almost self-determined—for example, in the case of the Dublin school of the early nineteenth century—but is instructive in other less well-defined groups. References to the parochial polemics of various places and periods are interesting and illuminating.

This book is recommended to all students of medicine and not merely to those historically inclined. It contains much wisdom and this, withal, attractively presented. The illustrations, consisting principally of reproductions from drawings and photographs of various great physicians, are a study in themselves. The production of the book is of the usual high standard of such works.

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**War Injuries of the Chest.** Edited by H. MORRISTON DAVIES, M.Ch., F.R.C.S., and ROBERT COOPE, M.D., F.R.C.S.; 1942. Edinburgh: E. and S. Livingstone. 7½" × 5", pp. 139, with 36 illustrations. Price: 6s. net.

THIS small monograph is an excellent addition to the military surgeon's library. Its small size makes it suitable for the surgeon even at an advanced station. It is a symposium by nine members of a chest surgical unit of the Emergency Medical Service.

There is a short anatomical and physiological introduction, which is very good indeed and will be found useful by all surgeons. The diagrams are most lucid. Each particular division of chest injuries is dealt with in a chapter. There is of necessity considerable condensation, but the field is covered in a most satisfactory way. We do not agree with all the statements made—for example, that introduction of air should be carried out invariably when a hæmothorax is aspirated. In addition, it is clear that the question of immediate operation is considered from the point of view of patients being brought direct to a hospital. The problem in the field is a very different one and deserves mention in a work such as this.

The arrangement of material is good and relative values have been assessed carefully in its compilation. The emphasis placed on local anæsthesia is noteworthy and justified by experience. One feature, however, that of late after-care and

rehabilitation of patients with chest wounds, in our opinion, deserves much greater emphasis than it has received.

This volume is one that can be recommended to those dealing with chest wounds, and will be of very great value to younger surgeons who find themselves faced with these potentially difficult cases.

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**Surgery of Modern Warfare.** Edited by HAMILTON BAILEY, F.R.C.S.; Second Edition, 1942. Edinburgh: E. and S. Livingstone. Volume I, 9 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ ", pp. 496, with 375 illustrations. Price: 40s. net. Volume II, 9 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ ", pp. 530, with 544 illustrations. Price: 40s. net.

UNDER the conditions prevailing in England, the appearance of a new edition of "Surgery of Modern Warfare" is an achievement reflecting the determination of all concerned in its production to overcome the difficulties which beset that island. In the circumstances, it might be churlish to offer any criticism were it not for the fact that it is claimed in the preface that the work represents British surgery.

There are some very excellent chapters, but there are some which we cannot regard as truly representative of British surgery as we know it. Among the former are those of H. H. Sampson on recent wounds, Seymour Barling on infected wounds, and Leonard Cole on tetanus. These could be read with profit by any surgeon, and should be read by all "trained but not necessarily highly experienced" surgeons, for whom, it is stated, the book is intended. The chapter on the treatment of injuries to the peripheral nerves written by Souttar in the first edition has been replaced by a much more satisfactory and practical account by Seddon.

Although the chapter on gas gangrene has been rewritten and is now the joint contribution of the previous author and the editor, it remains unsatisfactory. The low incidence of gas gangrene in the campaigns in the Middle East was not due to the fact that the men wore cotton shirts. Most of the fighting was done in the winter and the usual clothing consisted of sheepskin jerkins, woollen tunics and woollen underwear. The chapter on transfusion has not been altered and our former criticism remains applicable. The chapter on chemotherapy has been altered, but scarcely improved. It is not helpful to read that serum should be given "intravenously or intramuscularly" because the rapidity of action and the attainment of maximum concentration differ with the two methods; nor should such expressions as "emetine or Emetine-bismuth-iodide" and "a suitable diet" be used without elaboration in relation to the treatment of amœbic dysentery. The administration of opium to men suffering from acute bacillary dysentery will not be accepted by most physicians. In a book on the surgery of warfare there seems little point in inserting a standard textbook illustration of side-to-side anastomosis of bowel in an article dealing with bacillary dysentery.

The chapter on the surgery of the eye has been criticized previously on the grounds that much of this work does not come within the category of emergency surgery and should, therefore, be left to the skilled ophthalmological surgeon. The same criticism applies to a profusely illustrated chapter on facial reconstruction; the building of new noses, the use of inlay grafts and of hinged cartilage grafts is work for the man whose life is devoted to plastic surgery and not for the ordinary surgeon.

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**Practical Malaria Control.** By CARL E. M. GUNTHER, M.D., B.S., D.T.M., with a foreword by HARVEY SUTTON, O.B.E., M.D., F.R.A.C.P., B.Sc., D.P.H., F.R.San.I.; 1942. Sydney: Consolidated Press, Limited. 7 $\frac{1}{2}$ " x 5", pp. 91. Price: 6s. 6d.

THE handbook "Practical Malaria Control" is written in concise form and records the results of the author's experience in the treatment and control of malaria in the Mandated Territory of New Guinea, where he spent many years as a medical officer.

The book is divided into three parts: firstly, the author deals with the measures which could be taken for the control or elimination of the disease; secondly, he describes methods of diagnosis and, thirdly, methods of treatment of the disease. It is a valuable handbook and should be read by every practitioner. It is particularly appropriate in these days when malaria is such a vital problem for our Australian and Allied Forces who are at present so actively engaged in the South-West Pacific.

